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# COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

**May, 1947**

Night scene at Trenton Channel Power Plant of The Detroit Edison Company

**HAMMERMILL BOND Extends Its Power Plant ▶**

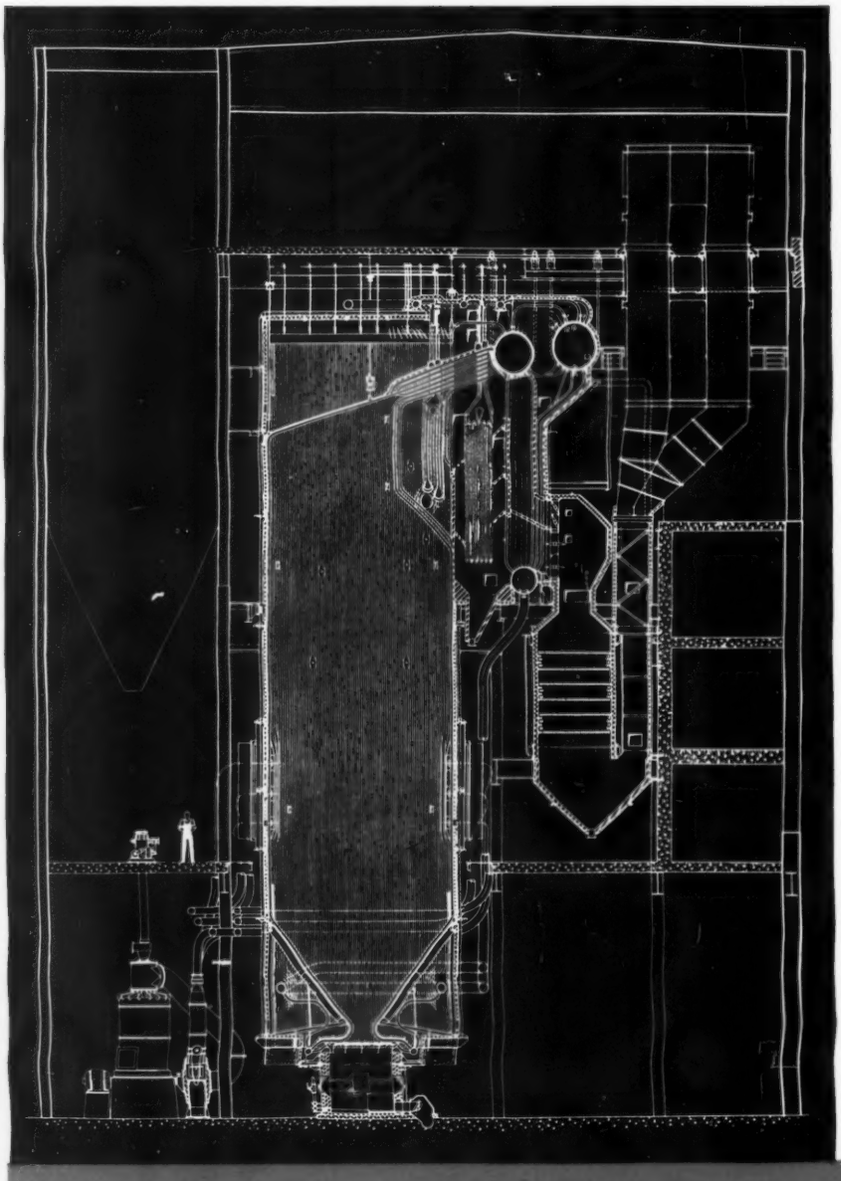
**Simplified Plant Control Test for Boiler-Water Dissolved Solids ▶**

**New Utility Boilers ▶**

# Recent C-E Steam Generating Units for Utilities

# B. C. COBB STATION

## CONSUMERS POWER COMPANY



THE C-E Unit, illustrated here is one of two such units ordered in 1946 for the B. C. Cobb Station of the Consumers Power Company at Muskegon, Michigan. A third unit has recently been ordered.

Each unit is designed to produce, at maximum continuous output, 600,000 lb of steam per hr at 875 psi and a total temperature of 900 F.

The units are of the 3-drum type with 2-stage superheaters. Furnaces are fully water cooled with closely spaced plain tubes and are of the basket-bottom type. C-E economizers and plate-type air heaters follow the boiler surface.

Pulverized coal firing is used employing C-E Raymond Bowl Mills and Vertically-Adjustable, Tangential Burners. This burner arrangement, in conjunction with Montaup-type by-pass dampers, assures accurate control of superheater temperatures. B-129

**COMBUSTION ENGINEERING**

**200 MADISON AVENUE · NEW YORK 16, N. Y.**

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

# COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME EIGHTEEN NUMBER ELEVEN

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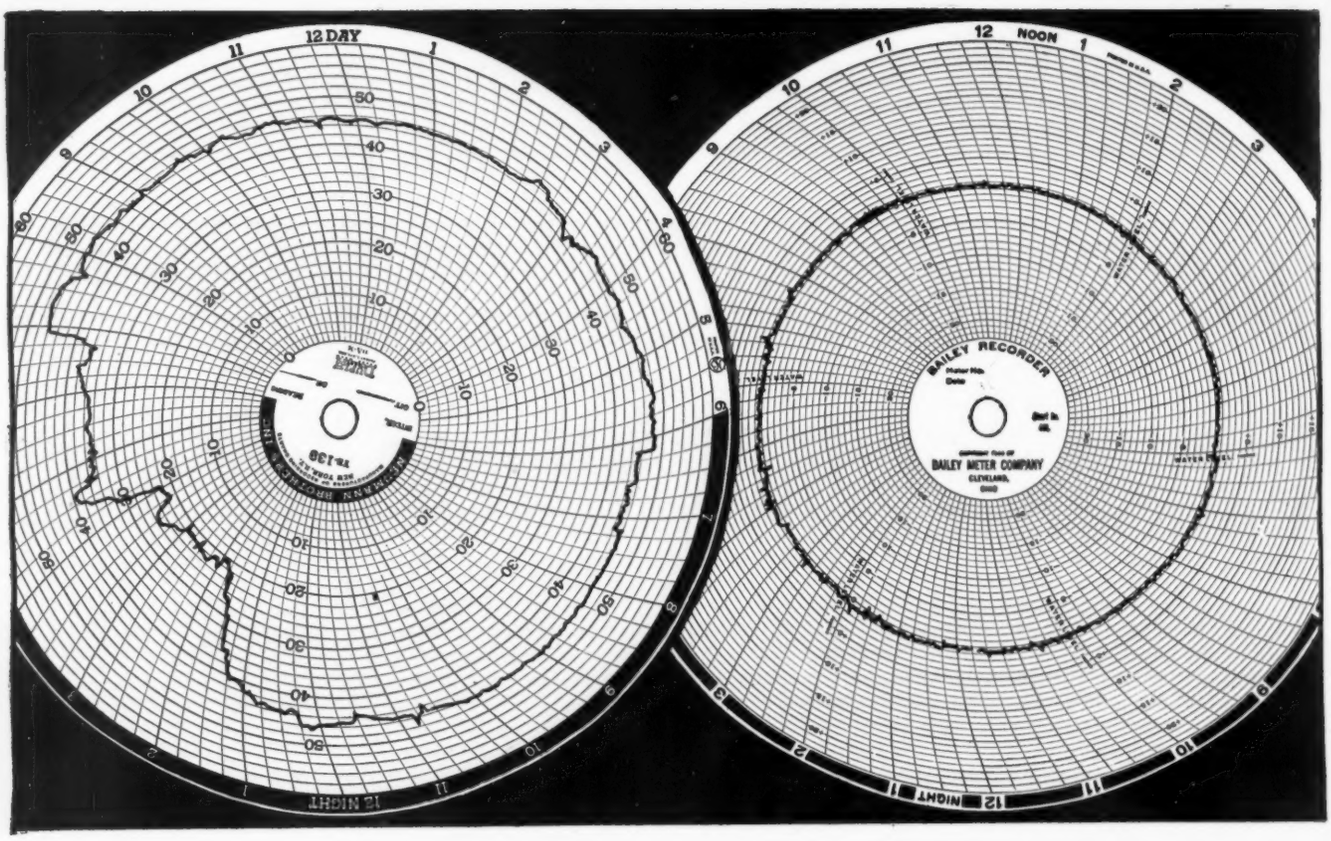



# COPES FLOWMATIC CONTROLS

## water level within plus-or-minus ½-inch

WITH the load range from a minimum of 200,000 to a maximum of 480,000 pounds of steam per hour on this 675-psi, 900-F Combustion Engineering three-drum boiler, two-element COPES Flowmatic Control is stabilizing water level within plus-or-minus one-half-inch. Feed is divided between two lines, with a relay-operated Flowmatic Valve in each line.

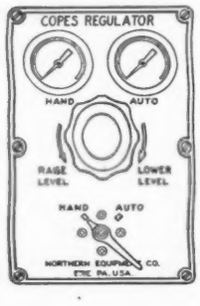
Results have been uniformly satisfactory over the five years since the first COPES Flowmatics were placed in regular service. Three other steam generators in the station have since been equipped with duplicating COPES Flowmatic Control.

The charts above are taken from Bulletin 467, an 8-page performance report on this installation. This report reproduces two other sets of charts, as well as a sectional view of the type of boiler in service and plant photographs. This informative publication is yours for the asking. Write—on your letterhead, please—for a copy.

NORTHERN EQUIPMENT COMPANY
576 GROVE DRIVE, ERIE, PENNSYLVANIA
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters
BRANCH PLANTS: Canada, England, France
*Representatives Everywhere*

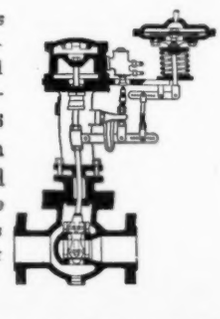
## ★ GET CLOSER LEVEL CONTROL WITH COPES FLOWMATIC

### AIR-OPERATED REMOTE CONTROL




Permits absolute flexibility of installation for COPES Feed Water Regulators of either simple-level-control or two-element Flowmatic type. COPES transfer switch and control panel illustrated provides remote positioning of feed valve from boiler operating board or any other desired point. Air is used as the operating medium. Dependable performance is demonstrated daily in many COPES-equipped high-duty steam-generating stations.

### PRESSURE REDUCING VALVES



Ideal for those applications where results not attainable with "stock" valves are desired. There are eight types, direct-and relay-operated, from which COPES engineers select the one best suited to demands of the individual installation, then design ports and pressure range for the specified conditions. Low friction, accurate balance and ample power. Available as single units or for multiple installations. COPES Master Control permits remote operation.

# EDITORIAL

## Distribution of Coal Costs

To all users of coal today and particularly to those responsible for the efficient production of heat and power services, the cost of this commodity has become an important factor. For those areas remote from the mines the greater portion of the cost is attributed to transportation. However, most of the increase in delivered cost today is attributed to a higher price at the mine. The distribution of the coal producer's sales dollar was given in the 1946 annual report of the Pittsburgh Consolidation Coal Company.

The largest portion of the sale price, amounting to sixty per cent, went to employees. Of this 56.4 per cent was for miners' wages and paid vacations, the remainder going to social security, employee compensation and insurance and the miners' welfare fund. Out of the remaining forty per cent almost nineteen per cent was used for mine supplies and power. Other operating costs, including insurance royalties, administration and selling, account for 8.7 per cent. Remaining cost items include 4.4 per cent for depreciation of equipment and exhaustion of coal reserves and 4.1 per cent for taxes.

After meeting payroll and other expenses only 4.1 per cent of the selling price at the mines was left for the owners. This was used to pay dividends to stockholders and for improvements and to conduct research work to increase and broaden the markets for coal.

While this distribution covers only one large company it might be considered as fairly representative at least of coal mined in the region covered by properties of the Pittsburgh Consolidation Coal Company.

## New British and American Steam Capacities Compared

Approximately six million kilowatts of new electric generating capacity has been approved by the British Central Electricity Board for installation in eighteen new stations and extensions to numerous existing stations up to the end of 1950. This program involves 288 steam-generating units and 145 turbine-generators in which, according to the recently issued Annual Report of the Board, a considerable degree of standardization has been carried out.

Except for some boilers and turbine-generators that will duplicate units in existing plants, the boilers will fall within three capacity groups of 200,000/265,000, 300,000/365,000 and 525,000/540,000 lb per hr; and three pressure groups of 600, 900 and 1200/1400 psi. Only two units fall in the largest capacity range and sixteen in the 400,000/450,000-lb per hr range. There are nine in the 1200/1400-psi group and ninety will operate at 900 psi. Unfortunately, no information is given as to total steam temperatures or methods of firing.

As to the turbine-generators, fifty are rated at 30,000 kw, sixty at 50,000/60,000 kw and ten at 40,000/45,000 kw, the remaining twenty-five units being of various sizes.

This information affords opportunity for interesting comparison with similar data pertaining to units now on order for American central stations, as reported elsewhere in this issue. The most striking difference appears to be the generally smaller steam-generating units among the British stations although, with few exceptions, the turbine-generator sizes compare with American practice. The answer appears to lie in the fact that British practice generally favors two boilers per turbine, whereas in many of the later American plants the unit arrangement of one boiler per turbine is followed. Moreover, a very much larger proportion of the American units will operate at 1300–1500 psi, with ten exceeding this pressure; whereas none of the British units will exceed 1400 psi.

Finally, comparison of the ratios of the new to existing capacities in the two countries is interesting. In the United States steam central stations account for slightly more than 34 million kilowatts, and an estimated nine million kilowatts is on order; whereas in Britain, according to the Board's Report, the present central station capacity of stations supplying the Grid is approximately $11^1/_3$ million kilowatts and additional capacity of about six million kilowatts has been approved. Thus, while steam utility capacity is being increased about 26 per cent in this country, in Britain it is being increased 52 per cent.

## Economy Drive Squeezes Research

The economy drive which Congress is now pressing has tentatively lopped off a large slice of the Interior Department's requested 1948 appropriation. This has brought forth strenuous Administration protest, although the department still has a large unexpended balance on its current allotment. The major portion of the huge budget contemplates further large hydro development in the West as well as a number of reclamation projects. Unfortunately, the relatively modest sum planned for the Bureau of Mines seems destined to suffer through curtailment of the research program on production of liquid fuels from coal and shale. That is, in attempting to control public power expenditures Congress seems to have penalized some much-needed research.

# HAMMERMILL BOND Extends Its Power Plant

By EARLE M. SOMMERFIELD
Chas. T. Main, Inc., Boston

**This extension consists of two 150,000-lb per hr, 675-psi, 775-F, pulverized-coal-fired steam-generating units; a 7500-kw double-extraction condensing turbine-generator; a new coal-handling system; a revamped ash-handling system; and a new hot lime-and-soda feedwater treating plant. Restricted space and necessity for maintaining full service to the paper mill during construction involved many problems which are discussed. This extension raises the total turbine-generator capacity, in six units, to 22,500 kw.**

THE Hammermill Paper Company of Erie, Pa., manufacturer of fine papers, is nearing the completion of extensive additions and improvements to its No. 2 Power Plant. The first boiler addition, No. 18, is already in operation, supplying 150,000 lb of 675-psi 775-F steam per hour for power generation and process. This has permitted the demolition of No. 1 Power Plant, which contained three chain-grate-fired boilers, the removal of which yielded valuable space for extension of manufacturing facilities. It is expected that the second boiler addition, No. 19, of like capacity will be ready for service in the near future; likewise the new hot lime-and-soda feedwater treating plant which will permit simultaneous operation of the two new boilers. Station service switching will soon be ready for service, and installation of a new 7500-kw 13,800-volt double-extraction condensing turbine-generator will be completed in June. New ash-handling facilities are already in service and the completion of a new coal-handling system of 150 tons per hour capacity will be realized in the near future.

Construction of this plant extension has been carried on during the difficult post-war period of strikes, as well as material and manpower shortages. It has been necessary to resort to all possible expedients to improve the starting dates, especially that of No. 18 boiler in order to permit the construction of new paper manufacturing facilities to proceed. Resort was had to many second-hand motors, and No. 18 boiler was started and run for a considerable period on temporary wiring and switching equipment. Furthermore, delays of various sorts forced construction to continue through difficult winter conditions, which made extensive temporary enclosure necessary.

No. 2 Power Plant is located in a depression with a forty-foot bluff enveloping the plant on three sides and the other side bordering on the edge of Lake Erie. This topography restricted available space which made necessary a compact layout and required resourcefulness in design. As will be seen by reference to Fig. 1, the boilers were added at the south; the main switch room to the east; the turbine room extension and feedwater bay to the north, and the chemical bay to the west; with coal unloading equipment placed on the south bank and the ash silo on the west bank. The topography also gave rise to many drainage and access problems.

This new boiler capacity not only replaces boiler capacity in No. 1 Power Plant, but it will also provide additional capacity for a new paper machine. Plant No. 2 previously consisted of two Babcock & Wilcox integral-furnace, 675-psi, 775-F pulverized-coal-fired boilers, and four 250-psi, 125-F, longitudinal drum units fired with chain-grate stokers. Normally, the stoker-fired capacity will not be required but will serve as standby. Future expansion will consist of the addition of two more 150,000-lb per hr units to be installed in the space now occupied by the four stoker-fired boilers.

### *Details of Boiler Plant Extension*

The boiler plant extension consists of two Combustion Engineering Company 150,000-lb per hr, 675-psi, 775-F, Type VU steam generators having steam drums equipped with reversing hood washers. Each is served by two Raymond bowl mills located in the basement. Supplementary oil firing is provided for lighting off and light loads. There are four horizontal turbulent-type burners per boiler. Draft is furnished by motor-driven Sturtevant forced- and induced-draft fans, each with inlet vane control, and the gases are exhausted through Prat-Daniel tubular dust collectors to the existing stacks. Combustion air is preheated by a Ljungstrom air preheater to a temperature of 500 F.

Soot blowers are of Diamond type and consist, for each boiler, of one Type IK retractable, one rear-wall Type IJ, four side-wall Type IR, one calorized, two dialoy and three steel elements on each side of the furnace. Saturated steam at 650 psi is used for soot blowing.

Two Stock Engineering Company coal scales are provided for measuring coal to each boiler, and Copes "Flow-matic" feedwater regulators control the water supply to the boilers.

Three Worthington 250,000-lb per hr, 900-psi, stainless-steel fitted motor-driven pumps supply boiler feed. One of these previously was one of three 120,000-lb per hr, 800-psi pumps serving the old plant and was converted for service in the new plant. The remaining two old tur-

bine-driven pumps were retained at their existing capacity and pressure for light load week-end service. Selection of the number and capacity of the new pumps was based on an ultimate load of 750,000 lb of feedwater per hour.

A loop system for boiler feed is employed which is quite flexible and can be extended to serve two future 150,000-lb per hr steam-generating units. Also, a main steam loop is provided which, like the boiler feed, is arranged for connection to two future boilers. The boilers have chemical feed connections in both the steam and mud drums.

The continuous blowdown system has a flash tank and blowdown heat exchanger. All sampling lines are run to a central laboratory, with the purpose of affording increased convenience to a point where one man can handle the major water treating and testing duties on one shift.

Bailey combustion control is installed and is arranged to operate in conjunction with similar equipment controlling the two earlier high-pressure boilers. The system is designed to maintain uniform steam pressure through control of the fuel supply, exhauster inlet dampers, and induced-draft fan inlet vanes. Induced draft is further adjustable on the basis of actual air flow to maintain fuel-air ratio conditions. The system maintains uniform furnace draft conditions through control of the forced-draft fan-inlet vanes.

Boiler auxiliaries are interlocked so that proper starting sequence must be maintained. That is, the induced-draft fans and the forced-draft fans must be running before it is possible to feed lighting-off oil to the burners. This is accomplished by means of a solenoid valve in the oil supply lines. Likewise, the pulverizers cannot be started until the fans are running, and the feeders cannot be started until the pulverizers are running. If the induced-draft fan or the forced-draft fan stops, all functions below it in the interlocking system drop out. Furthermore, feeder doors are interlocked to stop the feeder when the door is opened, and the coal scales are provided with no-flow alarms.

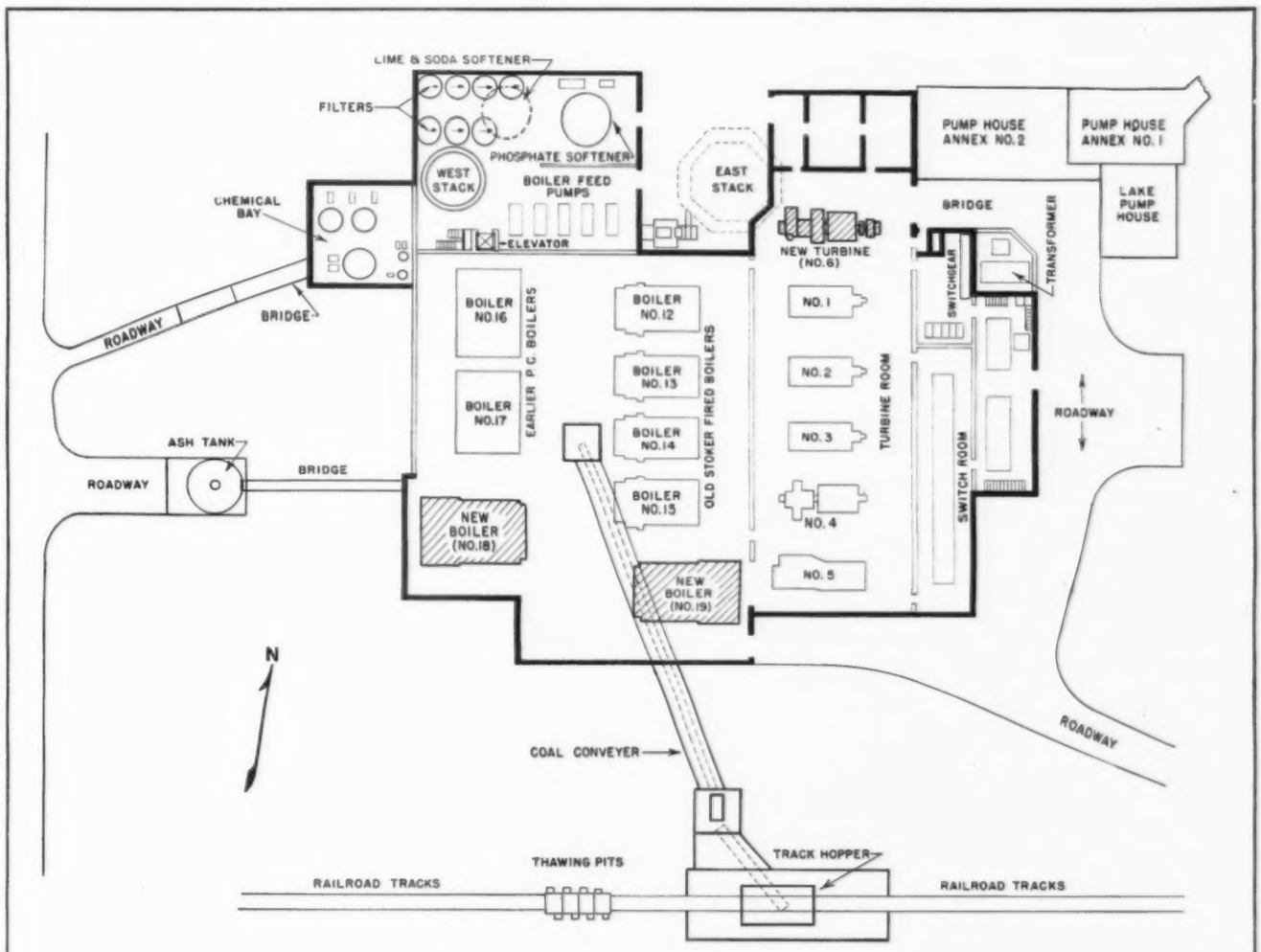



Fig. 1—General layout of Plant No. 2

The Bailey boiler control boards are located on the operating floor, one in front of each boiler. These boards are totally enclosed, with removable rear panels and are provided with a fan to maintain pressure inside the cabinet. The panels have a fluorescent lighting canopy. All major auxiliaries are controlled from the boiler control boards and instrumentation consists of a Bailey boiler meter recording steam flow, air flow and superheated steam temperature. A "Pyrotron" is used on the steam temperature recorder to avoid the disadvantages

of capillary tubing. Bailey seven-point draft gages measure pressures across the boiler and air heater, and four-point gages measure the pulverizer pressures. A Foxboro meter records drum water level and a Leeds & Northrup "Micromax" records air and gas temperatures at the air heaters. Drum, line and boiler feedwater pressures are indicated by "Duragages," and Reliance "Eye-Hyes" indicate drum water levels. Ammeters are provided to indicate fan and pulverizer loads.

Steam quality is measured by the conductivity method. Samples are taken at the superheater saturated and superheated headers on each boiler and at another point on the main steam header. This permits checking the steam quality in the header and if it is off, checking each individual boiler to determine the offender. Sampling lines are of stainless steel and are run to the central laboratory, again for convenience. Straub degassifiers are used in conjunction with Leeds & Northrup conductivity cells and a two-point recorder.

Auth annunciators are located on the boiler control panels to indicate high temperature of fan and pulverizer motors, high temperature of coal-air mixture to the burners and coal scale no-flow. Speaking tubes with signaling devices permit communication between the operating, fan and pulverizer floors.

The limited space conditions, coupled with the necessity of tying into and running through an existing plant, presented many piping problems, especially on long high-temperature lines where provision had to be made for considerable expansion.

### *Desuperheating System*

The old plant had a Bailey 160,000-lb per hr, 650-to-150-lb pressure-reducing station installed in conjunction with a Blaw-Knox desuperheater. Increased loads indicated that under certain conditions this capacity would be exceeded, so a new station of like type and capacity was installed in conjunction with a spray-type desuperheater. Boiler feedwater is used for desuperheating, although it was at first wondered if turbine blade plugging would result from the use of a spray-type desuperheater. It was desired to avoid the increased cost of desuperheater types that limit solids carryover; and, since the new reducing station will be used only at infrequent periods of short duration, decision was made in favor of the spray type. This complete pressure-reducing system, consisting of two old and two new reducing valves is controlled so that one of the old valves will first come into service; then the second old valve as demand increases; then the first new valve; and finally the second new valve. The reducing station is controlled from a control panel located in the boiler room.

An extensive system of platforms and stairways within the boiler plant make for convenience in operation and inspection.

### *Feedwater Treating System*

The old water-treating system consisted of a first stage of cold lime-and-soda process, followed by a Cochrane phosphate softener where water for the high-pressure boilers was treated, heated and deaerated. This was followed by supplementary phosphate fed directly to the boiler drums. Heating was accomplished by 10-psi steam reduced from 150 psi mill supply. Water heating for the stoker-fired boilers was accomplished by a Cochrane cast-iron feedwater heater, and boiler-feed-pump turbine-drive exhaust at 5 psi was used for heating the low-pressure boiler supply. City water is used for boiler makeup, but such water requires considerable treatment for high-pressure boiler operation.

Expansion of high-pressure boiler operation indicated extensive renovation of the existing treating equipment. Future expansion was also given consideration. It was decided that since the capacity of the old cold-process plant was exceeded, and more important, since this system did not reduce hardness to a desirable point for high-pressure boiler operation without excessive blowdown, that it be abandoned in favor of a new Cochrane hot-process softener of 50,000 gal per hr capacity. Backwash water storage capacity of 18,000 gal was provided on top of the new softener. The backwash storage compartment is divided into two sections. During the backwash period the backwash pump takes water from one of the storage compartments, discharges it through the filters and returns it to the other storage compartment. This then returns slowly to the phosphate softener. During the non-backwash period a small circulating pump takes water from filtered water storage and fills the emptied storage compartment for the next backwash. In emergency the backwash pump takes its supply from the phosphate softener and returns it thereto. The combination of the softener and the backwash compartments results in a tank 21 ft-6 in. diameter by 28 ft on the straight side of the shell. The softener is equipped with a stirring mechanism to hasten the chemical reaction and improve flocculation.

The new softener operates in conjunction with the existing phosphate softener, the system being designed on the two-stage principle. Heating steam at 13 psi, reduced from 35 psi extraction by the new Bailey reducing valves, first passes through the jet atomizing valve of the phosphate softener and thence to the condensate preheating section and jet preheaters in the new lime-and-soda softener. The existing phosphate softener has an internal treated water storage compartment. This compartment was too small for the proposed operation so was supplemented by an external treated-water storage tank 10 ft diameter by 20 ft long which increased the boiler feed-storage capacity to 17 minutes. In the future this supplementary storage tank will be equipped with a deaerator to deaerate condensate, since the capacity of the deaerating section of the existing phosphate softener will be exceeded. An equalizing line between the new softener and storage tank will act as a steam supply line to the future deaerator.

Mill and condenser returns are collected in a condensate tank and are pumped to the condensate heating section of the existing phosphate softener, then join the treated water, are deaerated and flow to storage.

Makeup water is fed through a new 8-in. 2000 ft underground supply line to the hot-process softener; through the softener to the existing phosphate softener; to the filters and back to the phosphate-softener treated-water storage compartment; and then to the boiler feed pumps. Provision is made for emergency supply to the boiler feed pumps by makeup water bypassing the softeners, condensate bypassing the softeners and finally by a mill water connection. In flowing to the hot-process softener the makeup water is measured by a flowmeter. This meter has integrator contacts which close after a predeter-

n.ned quantity of water has passed through and actuate the electrical proportioning device which controls lime-and-soda feed to the softener. The quantity fed is variable by a selector under control of the operator. For every ten lime-and-soda feeds, supplementary phosphate is fed automatically directly to the boiler drums. This cycle is also variable at the operator's discretion. Another orifice actuates the existing mechanical proportioner which controls phosphate feed to the phosphate softener.

tioned, will be removed when the new equipment goes into operation. Little chain-grate boiler operation is expected, so it was considered desirable to supply these boilers from the new treating system and eliminate the old system.

In emergency the lime-and-soda softener can be taken out of service, and lime-and-soda fed to the phosphate softener; likewise, the phosphate softener can be taken out of service and supplementary phosphate feed increased.

Fig. 3 (below)—East elevation of plant showing new switchhouse in foreground; lake front at right

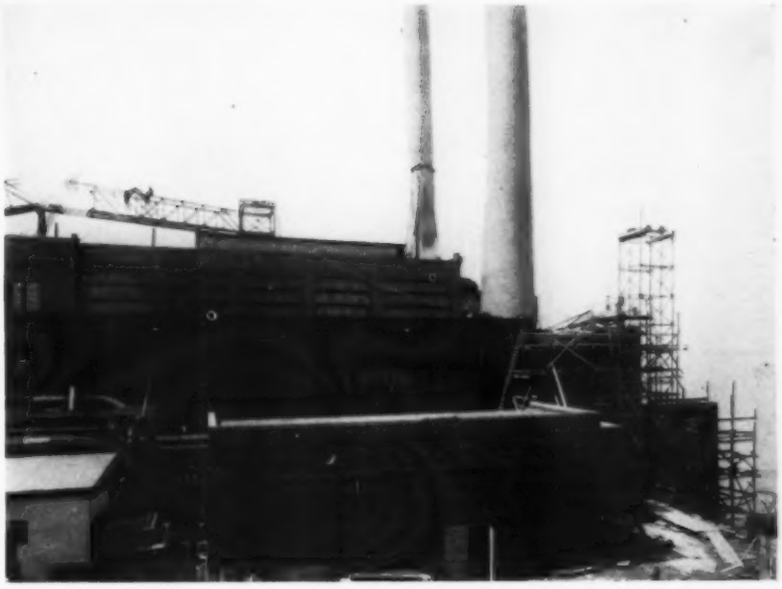


Fig. 2 (above)—West elevation showing new coal elevator, tower and belt conveyor, with ash tank and chemical bay in foreground

Two chemical mixing tanks for lime and soda of 12-hr capacity were added, together with electrical proportioning equipment and feed pumps. The existing phosphate mixing tank was replaced but the existing mechanical proportioning equipment and pumps were utilized. Existing supplementary phosphate mixing and pumping equipment was retained, adding two solenoid controlled discharge lines to the two new boilers. Sludge recirculating equipment was installed to increase flocculation. Sulphite and "Nalco 78" feeds are also provided.

Four filters were added to the existing three, the flow though the filters being limited to a maximum of 2.5 gpm per sq ft of filter area. The filtering material is anthracite.

The low-pressure Cochrane heater, previously mentioned, will be removed when the new equipment goes into operation. Little chain-grate boiler operation is expected, so it was considered desirable to supply these boilers from the new treating system and eliminate the old system.

The chemical bay consists of three stories taking advantage of the natural topography for gravity flow of chemicals. Chemicals will be brought in by truck over the west bank and over a new concrete bridge to the top floor of the chemical bay. A month's storage is provided in this room. The room is fitted with three large hoppers, one for lime, one for soda and one for phosphate. The hopper openings are at floor level and are covered with grating, the hoppers extending down into the scale room. Chemicals are discharged from the hoppers and weighed on a platform scale in the scale room. The weighed chemicals are then dropped into spouts at scale room floor level. These spouts take the chemicals to the mixing tanks on the floor below. This room also contains the chemical pumps and all control apparatus. The chemical

bay also includes the laboratory located on the scale room floor.

A passenger elevator with four stops has been provided in the new extension. This is located in the feedwater bay area and makes the laboratory, scale room, chemical storage room, station service switchgear rooms, fan floor and all intermediate platform levels in the boiler room and feedwater bay, quickly and easily accessible.

### *Coal-Handling System*

Coal supply to the old plant was accomplished by shifting coal cars in above the catenary bunker serving the boilers, the topography making this easy. That for the pulverized-coal-fired boilers was crushed by individual crushers after leaving the bunker and before going to the mills. The track which fed this simple coal-handling method, however, was in the way of paper-mill expansion and that above the bunker prevented the extension of the bunker upward to provide sufficient overhead storage. Therefore, since the ultimate development of No. 2 Power Plant will require 600 tons per day, unloading facilities for this quantity of coal in limited space posed a problem. Many sites and methods were studied, all of which had some undesirable feature. It was finally decided that the location possessing the lesser of evils was on top of the bank south of the power plant. A coal unloading house which will be heated and large enough to accommodate one 105-ton car was therefore built on the south bank and a single-tract hopper provided as indicated in Fig. 1.

Considerable difficulty had been experienced in the past in unloading frozen coal. This was not only expensive but interfered with plant operation. Keeping the job supplied with manpower was also a problem. It was finally decided to install oil-burning Hauck radiant-heat thawing pits on the far side of the unloading house, the stretch of track beyond which will accommodate four cars and can be extended to accommodate more. The last car in the shift will be set over the thawing pits and the car hopper thawed in 20 min or less. A car puller will then move this car into the unloading house where a Robins car shakeout is suspended overhead. It is expected that the combination of the thawing pits and the car shakeout will permit expeditious unloading of frozen coal and result in reduced costs.

The track hopper discharges to a pan feeder of 150 tons per hour capacity which discharges the coal to a ring coal crusher. Since space conditions did not permit the installation of an inclined belt entirely to the power house, it was necessary to install a bucket elevator to lift the coal 75 ft from the crusher discharge to the belt. This belt, about 120 ft long, runs up an incline as far as the south wall of the boiler plant. It then runs horizontally above the roof of the boiler plant to the central point of the coal bunker where it drops the coal into a chute after passing a magnetic pulley. The coal falls to a shuttle belt conveyor which distributes it to any desired point in the bunker. All the conveyors are interlocked for proper starting sequence and dropping out in case of failure of some part of the system. The coal-handling equipment was designed and furnished by the Stephens-Adamson Mfg. Co.

The coal bunker is of the box type for maximum capacity of 10 tons per lineal foot and in the future will be extended upward to provide a capacity of 20 tons per foot which will give approximately 50 hr live storage. This will permit a five-day coal-handling schedule. When the bunker is extended upward, the shuttle conveyor will be relocated on top of the boiler house roof. The expense of enclosing the shuttle in this location at this time was decided against and the shuttle was located in a lower position under the existing coal bunker roof.

### *Ash-Handling System*

The ash-handling system formerly consisted of a United Conveyor "Nuveyor" system with dustless unloader serving the two earlier pulverized-coal-fired boilers, the stoker-fired units being served by small-gage cars to a skip hoist. Pulverized coal and chain-grate ash were collected in separate bins located above the track at the far end of the coal bunker. The bins were discharged into railroad cars which were taken to fill and unloaded with a crane and clam-shell bucket. This system required considerable labor, the use of expensive equipment, and added to yard traffic.

A "Nuveyor" system was decided upon for the new boilers and tied into the existing system. An extension was made to the west stack and chain-grate ash hoppers which were adapted to the new system. A new ash silo was provided on the top of the bank west of the plant, the existing dustless unloader moved thereto and another dustless unloader added. Conveyor air is discharged to the west stack which eliminates the necessity of an air washer. A structural steel bridge carries piping from the plant to the silo. This bridge is designed to permit easy access to the piping. Trucks now handle ash directly to fill which has greatly reduced labor requirements and dust and dirt from the chain-grate area. The design of this system anticipated the future increase in boiler capacity, and all ash is handled in one shift with a minimum of personnel and equipment.

### *Turbine-Generator Plant Extension*

The old turbine-generator plant consisted of three General Electric 2000-kw 2300-volt, 225-psi 125-F superheat straight condensing machines, one General Electric 4000-kw 2300-volt, 650-psi 750 F throttle, 150-psi back-pressure machine and one Allis-Chalmers 5000-kw 2300-volt, 150-psi throttle, 35-psi back-pressure machine. The three 2000-kw condensing units were inefficient because of low throttle pressure and condensing losses, coupled with the relatively inefficient old stoker-fired boilers by which they were normally supplied. Elimination of this uneconomical phase and provision of additional electrical capacity as well as more 150- and 35-psi process steam capacity for plant expansion, dictated the selection of a 7500-kw 0.80-pf, 3-phase, 60-cycle, 13,800-volt, 3600-rpm, 650-psi 750-F double automatic-extraction condensing unit with direct connected exciter, located in an extension to the turbine room.

Removal of any existing turbine to provide space for the new would have resulted in insufficient reserve capacity. The new turbine-generator was furnished by the Generator Electric Company, and the condenser and auxiliaries by Foster-Wheeler. Existing circulating water pumps had sufficient capacity to provide condensing water for the new unit. The condenser is served by two motor-driven condensate pumps and a steam-jet air ejector. It is expected that the flexibility of the new unit in conjunction with the two existing back-pressure

units will make operation most economical under all load conditions.

A Bailey turbine panel is provided on which is mounted three steam-flow meters recording flow to the turbine and from the two extraction points. These meters also record corresponding steam pressures. Steam temperatures at the three points are recorded by a Leeds & Northrup meter. A mercury column vacuum gage, turbine pressure gages, air meter and speed indicator are also mounted on this panel.

Turbine-room annunciators are located on the switchboard and indicate main and station supply breaker outage, Nos. 4, 5 and 6 generator differential relay trip, tie transformer differential trip, oil level and oil temperature, and 150-psi steam high temperature, and high pressure from the 650-to-150-psi reducing desuperheating station.

Since installation of No. 19 boiler blocked the existing and only access to the turbine room, it became necessary to provide access at another point. This was effected by constructing a concrete bridge from the toe of the east road to the turbine room operating floor level just east of the new turbine-generator installation. A large hatch is provided in the operating floor to permit lowering of materials and equipment to the basement floor level. The existing east stack is so located that it would not permit the extension of the existing crane rails. Therefore, a new 20-ton Shaw-box crane with motorized hoist was installed to serve the new turbine-generator and handle parts of the old units to the new access.

The new generator transformer, 8000 kva, 13,200/2400 volts of the outdoor type furnished by Allis-Chalmers, is set east of the turbine room and north of the switchroom on the new bridge as it turns the corner to the turbine room. Switchroom redesign and extension required the space occupied by existing office and locker room. Hence, new office and locker room facilities were provided in the north end of the new turbine-room extension. The locker room is located on the operating floor level with the office above. Space at basement floor level below these facilities will be used for storage.

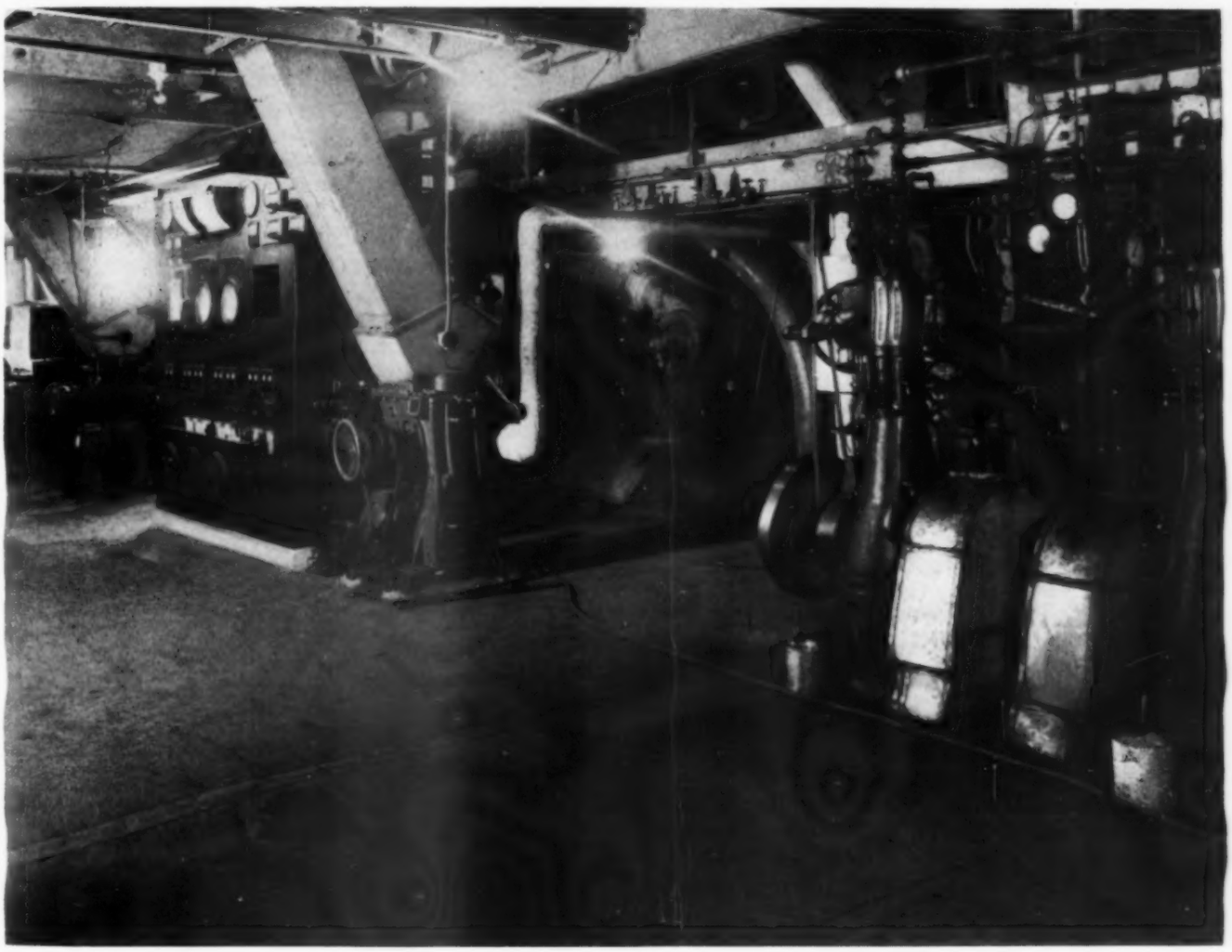


**Fig. 4—Boiler room operating floor showing front of boiler No. 18**

*Main Switching and Station Service*

The main switching equipment in the old plant was located in an adjoining structure to the east. This was undisturbed with the exception of office and locker facilities referred to previously. A new adjoining structure was provided to the east of the old switchroom to house the new main 13.8- and 2.4-kv air-break, metal-clad,

drawout switchgear. This extension is a three-story building with feeder reactors at the basement level, switchgear at the operating level and synchronizing reactors and bus on the upper level.

The station service switchgear in the old plant was housed north of the boiler aisle, but this space was not adequate to house the new switchgear. Therefore space was provided on two levels in the feedwater bay extension with 2300-volt gear occupying the lower level and 440-volt gear the upper level.

The additions to and changing of existing electrical facilities and building around them while keeping the plant in operation presented many construction and scheduling problems.

The old generating equipment is 2300 volts; the new is 13,800 volts; and the two systems are tied together by the new 8000-kva, 13.8/2.4-kv transformer previously

**Fig. 5—New hot lime-and-soda tank under construction**

mentioned. New manufacturing facilities are fed with a transmission voltage of 13,800 volts. New substations throughout the plant reduce this to the proper utilization voltage.

The addition of the new generating capacity resulted in increasing interrupting requirements beyond the capacity of the existing switchgear, and this was overcome by sectionalizing the buses and by the addition of reactors to the system.

The old 2300-volt station service bus was originally in duplicate with auxiliaries divided for maximum reliability. The new scheme divides the boilers between two bus sections with a tie breaker between sections. Also divided are the 440-volt auxiliaries which are fed from the two sections of the 2300-volt bus through transformers. Lighting service is divided. The two bus sections are fed by separate feeders. Normally the tie breaker between bus sections is open. In case of failure of either bus supply feeder, the tie breaker closes maintaining service on all auxiliaries. Undervoltage protection is provided on each bus section and on motors with the exception of forced-draft fan and pulverizer motors which drop out on undervoltage of the induced-draft fan drive by sequence interlock. The main switchgear was furnished by General Electric and station service gear by Westinghouse. Reactors were furnished by General Electric and Metropolitan Device Corp. All station service motors 50 hp and above are 2300 volt; below this horsepower they are 440 volt.

*Miscellaneous Improvements*

Kidde $CO_2$ protection was installed for the new generator and extended to Nos. 4 and 5 generators as these three generators will normally be in operation. The $CO_2$ system is automatic and will be actuated by both thermal contacts in the generator housing and generator differential relays. Hose connections have been provided throughout the turbine and boiler plants at such locations that the entire plant can be reached by the use of 100-ft lengths of hose. Manual $CO_2$ applicators are placed in the old switchroom where oil breakers are in use, and manual chemical applicators are provided in offices, chemical and feedwater bays. The new transformer is filled with a noninflammable liquid which eliminates necessity of protecting this unit from fire.

A new stationary Hoffman vacuum cleaning system will be installed. It will consist of an exhauster and primary and secondary separators.

A lube oil purifying system will be installed to serve the new turbine-generator, as well as Unit No. 4, and provision is made for extension of this system to the other units. The system is of the Nugent cotton-waste cartridge filter type. In conjunction with this, an existing centrifuge is incorporated for standby. All oil used in each turbine is continuously purified. The system is flexible enough to purify by batch method if this becomes necessary. Clean and dirty oil storage tanks facilitate changing oil in individual systems in minimum time.

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# Simplified Plant Control Test for Boiler Water Dissolved Solids

By J. J. MAGUIRE* and J. W. POLSKY†

**A report on the employment of gallic acid, in place of sulphuric acid, for neutralization in measuring the conductance of boiler water to determine the solids content. Advantages of gallic acid for this test are its simplicity and accuracy.**

THE solids concentration of a boiler water is one of the most important factors influencing proper boiler water control. A knowledge of such concentration is important from the standpoint of steam purity, since at high boiler water solids content there is increased tendency for carryover with the steam. Control of these solids below a critical value affecting steam purity is obviously required for trouble-free operation. It is customary for boiler manufacturers to limit the boiler water solids concentration at which steam purity is guaranteed. Also, from the standpoint of clean boiler heating surfaces, control over the solids concentration of the boiler water is paramount, for accumulations of scale or sludge deposits in a boiler are frequently caused by lack of proper control of the solids concentration.

While knowledge of the boiler water solids concentration is of great importance, the actual determination of this value is made only infrequently. This is not so surprising when it is realized that the gravimetric determination of total, suspended and dissolved solids is a tedious procedure involving careful evaporation of a boiler water sample to dryness under laboratory conditions. An analytical balance is required for weighing. Obviously considerable time is necessary for the determination, and careful laboratory technique is required for accurate results. Gravimetric determination is not suitable as a control test in the hands of non-laboratory personnel.

For some years determination of the specific conductance of boiler water has been employed as a measurement of the dissolved solids content. The conductance of a boiler water is caused by the various ionized salts present in solution. Pure water, free of ionizable solids, possesses a very high resistance and thus a very low conductance. Normally, the higher the concentration of ionizable solids present, the greater will be the conductance of the sample. A measurement of the total ionic concentration of a water sample can be obtained, therefore, by measuring the electrical conductance of the solution. For this purpose, there are available simple instruments such as Fig. 1.

Since the conductance of a boiler water sample is caused by the various ionized salts in solution the conductance test itself is not specific for any one ion, but rather is a measure of the total ionic concentration. Because of this property, the determination of specific conductance serves as a measure of dissolved solids content.

Naturally, the suspended solids content of a boiler water cannot be determined by conductance since these solids, being insoluble, do not ionize. Similarly, many organic compounds which do not ionize will not impart conductance to a solution. However, normal boiler water samples contain only a relatively small percentage of organic matter and the proper determination of specific conductance will provide an accurate measure of the inorganic salts which constitute the major portion of the boiler water dissolved solids.

It is customary for each plant to determine a factor for converting the measured specific conductance value to parts per million (ppm) dissolved solids. This factor will vary from plant to plant but can readily be determined for any given set of conditions by comparing the observed conductance reading with gravimetric determinations of dissolved solids on the same sample. A series of ten samples will provide sufficient data for developing an average factor for a given set of conditions.

A flaw in this method of measuring dissolved solids through multiplication of observed conductance by a factor is the very high conductance possessed by the hydroxyl ion. Reference to Fig. 2 indicates that of all the ions commonly found in boiler water, the hydroxyl ion possesses the greatest conductance. Consequently a relatively small change in the alkalinity of a boiler water sample will cause a fairly large change in conductance. The reliability of the conductance method for

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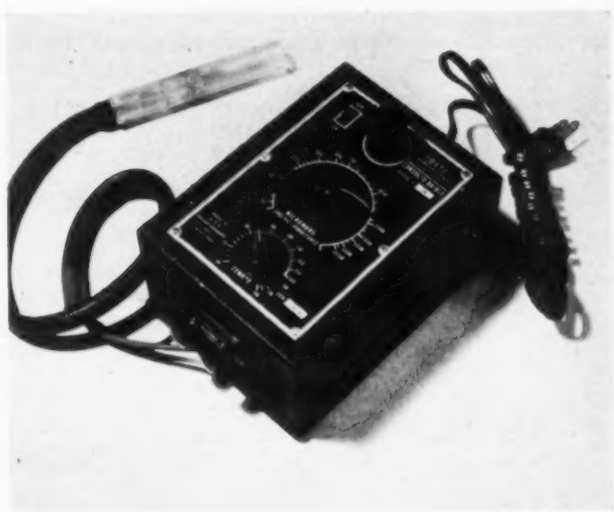


**Fig. 1—Conductance instrument for plant control of boiler water concentration**

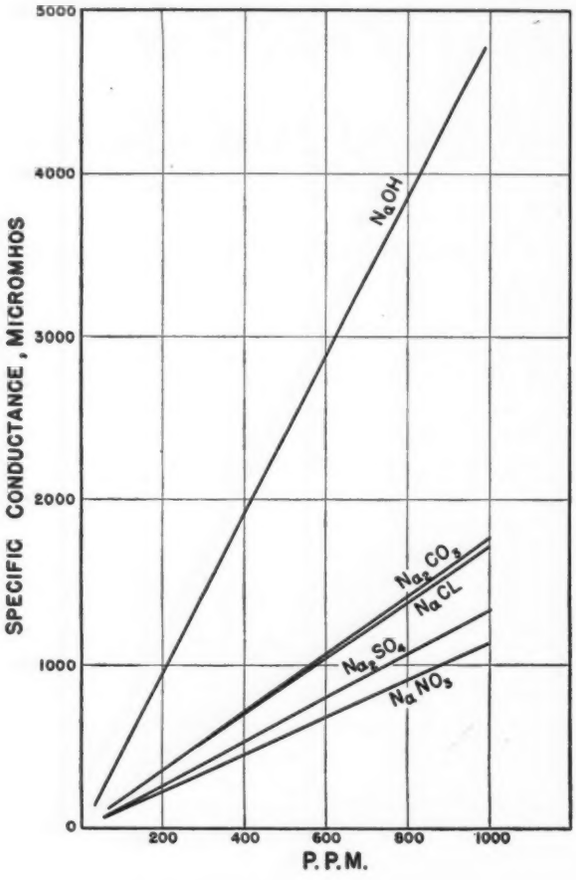



**Fig. 2—Conductance of common boiler water salts**

dissolved solids control is adversely affected by this property of the hydroxyl ion.

Reference to Table 1 indicates the effect of high alkalinity concentrations on conductivity. In this series of tests, each sample contained 2000 ppm dissolved solids. The proportion of sodium sulphate and sodium hydroxide was varied and specific conductance determined. As can be observed, the ratio of dissolved solids per micromho of conductance varied from 0.21 to 0.80. Obviously, if one were dealing with a boiler water consisting chiefly of sodium sulphate and sodium hydroxide the use of specific conductance would not provide a proper control of blowdown and dissolved solids. Such a large variation in the factor for converting micromhos of conductance to parts per million dissolved solids would render the conductance test of little value.

### *Sulphuric Acid Neutralization*

This objection to the conductance method for determining dissolved solids has been overcome by neutralization of the hydroxide concentration of a boiler water sample, prior to determining conductance. Sulphuric acid (5 per cent) is commonly used for this purpose. Phenolphthalein indicator is added to a boiler water sample and then sulphuric acid is slowly added until the pink color of the indicator is just discharged. Then additional boiler water is added to the sample to just revive the pink color. If too much boiler water is added at this point, sulphuric acid can again be added, then boiler water until the color has been just changed from colorless to pink. The pH value at this point is approximately 8.3 at which point the hydroxyl and carbonate ion content have for all practical purposes been converted to sodium sulphate and sodium bicarbonate, as illustrated by the following reactions:

| | | | | | | |
|---|---|---|---|---|---|---|
| $2NaOH$ | + | $H_2SO_4$ | = | $Na_2SO_4$ | + | $2H_2O$ |
| sodium hydroxide | + | sulphuric acid | = | sodium sulphate | + | water |

| | | | | | | |
|---|---|---|---|---|---|---|
| $2Na_2CO_3$ | + | $H_2SO_4$ | = | $2NaHCO_3$ | + | $Na_2SO_4$ |
| sodium carbonate | + | sulphuric acid | = | sodium bicarbonate | + | sodium sulphate |

Reference to Fig. 2 will indicate the theory behind this acid neutralization. By converting the high conductance hydroxyl ion to the sulphate ion which possesses lesser conductance, the conductance of all ions remaining in the neutralized sample falls in the same general range. It is, therefore, possible by this neutralization procedure to obtain a more consistent relationship between the conductance on a neutralized sample and the dissolved solids concentration. The factor for conversion from micromhos conductance to parts per million dissolved solids will be more consistent and reliable.

However, sulphuric acid is a strong acid and if an excess of acid is added, and not reneutralized with boiler water, additional conductance is added to the test solution. Table 2 illustrates the effect of even a slight excess of acid in increasing the conductance of the same and producing erratic results. It is thus evident that the acid neutralization must not be carelessly handled.

Fig. 3

Fig. 4

Fig. 5

**Steps in determining specific conductance with gallic acid**

The sulphuric acid neutralization method in addition to possessing the disadvantage of grossly inaccurate results if over-neutralized, also requires the use of additional time for the test as well as additional reagents and equipment. For control purposes by non-chemically trained operators, this method leaves much to be desired. Because of the time and trouble involved, the neutralization procedure is frequently eliminated and control based simply on unneutralized conductance.

Research has been conducted to find an acid other than sulphuric which could be used for neutralization purposes. It was desired to secure an acid which could be added in excess so that there would be no need for careful neutralization. An acid which ionizes only to a small extent would fit these requirements.

TABLE 1—UNNEUTRALIZED CONDUCTANCE

| Dissolved Solids, Ppm | Sodium Sulphate ($Na_2SO_4$), Ppm | Sodium Hydroxide (NaOH), Ppm | Specific Conductance, Micromhos | Ratio Solids / Conductance |
|---|---|---|---|---|
| 2000 | 0 | 2000 | 9500 | 0.21 |
| 2000 | 400 | 1600 | 8000 | 0.25 |
| 2000 | 600 | 1400 | 7500 | 0.27 |
| 2000 | 1000 | 1000 | 5900 | 0.34 |
| 2000 | 1400 | 600 | 4800 | 0.42 |
| 2000 | 1600 | 400 | 4200 | 0.48 |
| 2000 | 2000 | 0 | 2500 | 0.80 |

TABLE 2

| | pH | Specific Conductance, Micromhos |
|---|---|---|
| Boiler water—unneutralized | 11.3 | 2450 |
| Boiler water—neutralized with 5% sulphuric acid | 8.3 | 2200 |
| Boiler water—neutralized plus 0.1 ml excess acid | 2.9 | 2700 |
| Boiler water—neutralized plus 0.2 ml excess acid | 2.45 | 3500 |
| Boiler water—neutralized plus 0.3 ml excess acid | 2.2 | 4200 |
| Boiler water—neutralized plus 0.5 ml excess acid | 2.0 | 5800 |

TABLE 3

| | pH | Specific Conductance, Micromhos |
|---|---|---|
| Boiler water—unneutralized | 11.3 | 2450 |
| Boiler water with 1 dipper gallic acid | 5.4 | 2000 |
| Boiler water with 2 dippers gallic acid | 4.2 | 2000 |
| Boiler water with 3 dippers gallic acid | 3.95 | 2000 |
| Boiler water with 4 dippers gallic acid | 3.8 | 2000 |
| Boiler water with 5 dippers gallic acid | 3.7 | 2000 |

TABLE 4—GALLIC ACID NEUTRALIZATION FOR CONDUCTANCE

| Dissolved Solids, Ppm | Sodium Sulphate ($Na_2SO_4$), Ppm | Sodium Hydroxide (NaOH), Ppm | Specific Conductance, Micromhos | Ratio Solids / Conductance |
|---|---|---|---|---|
| 2000 | 0 | 2000 | 2800 | 0.72 |
| 2000 | 400 | 1600 | 2750 | 0.73 |
| 2000 | 600 | 1400 | 2850 | 0.71 |
| 2000 | 1000 | 1000 | 2600 | 0.77 |
| 2000 | 1400 | 600 | 2550 | 0.78 |
| 2000 | 1600 | 400 | 2600 | 0.77 |
| 2000 | 2000 | 0 | 2700 | 0.74 |

### *Gallic Acid Neutralization*

Investigation was conducted of various organic acids such as acetic, malic, citric, benzoic, tannic and gallic acids. Gallic acid was selected because of the simplicity of its use. Several of the other acids investigated either required excessive quantities for neutralization or contributed materially to the sample conductance if added in excess.

The procedure for determining specific conductance using gallic acid for neutralization is quite simple, since gallic acid is a solid material and can be added by means of a small dipper. In this work a dipper holding 0.1 gram gallic acid was employed. No color indicator is required and reneutralization with boiler water is not necessary. The procedure is as follows using a sample of approximately 50 ml.

1. Add 2 dippers of gallic acid (0.2 gram) to the boiler sample. (See Fig. 3.).
2. Insert thermometer, set temperature dial on conductivity instrument and insert dip cell. (See Fig. 4.)
3. Read specific conductance directly from dial of conductivity instrument. (See Fig. 5.)

Due to the low degree of ionization possessed by gallic acid, the addition of an excess of the acid will not increase conductance to any significant extent. Table 3 illustrates that even a considerable excess of gallic acid will not increase the conductance of the sample and, unlike sulphuric acid, careful neutralization is not required. Two dippers of gallic acid (0.2 gram) will neutralize approximately 1300-ppm phenolphthalein alkalinity as calcium carbonate and is the quantity recommended for most boiler waters, based on a 50-ml sample.

Table 4 shows the advantage of the gallic acid neutralization as compared with unneutralized conductivity in producing a consistent ratio between conductivity and dissolved solids. Comparison of Table 4 with Table 1 will indicate the advantage of the neutralization method in producing this consistent relationship.

Table 5 shows the results obtained on typical boiler water samples from different sources by the three conductance methods namely, unneutralized, sulphuric acid neutralization and gallic acid neutralization. As can be observed with proper neutralization by means of sulphuric acid, a consistent relationship between dissolved solids and conductance is obtained. The relationship is much more consistent with the sulphuric acid and gallic acid neutralization methods than with unneutralized conductance.

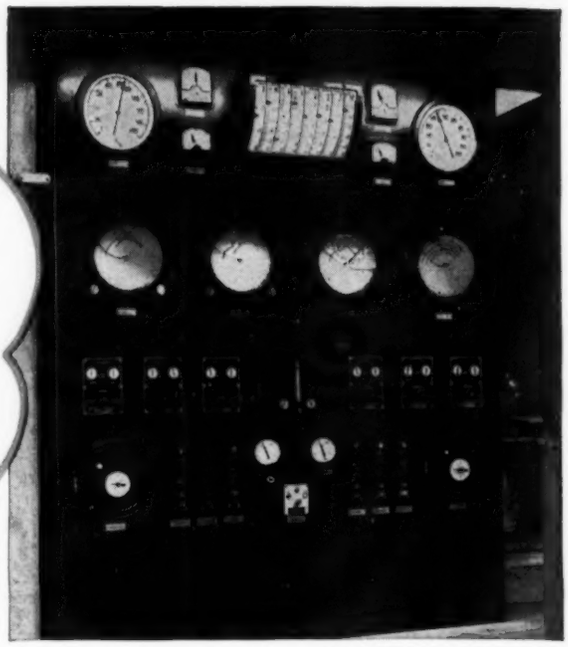
Because of the advantages of the gallic acid method particularly in the hands of non-chemical plant operators, this method is favored for plant control. All of the conductance values reported in the various tables were determined, not with laboratory conductivity equipment, but with the plant type equipment shown in Fig. 1.

The development of the gallic acid neutralization method is expected to rapidly replace the sulphuric acid method particularly for plant control work. The more accurate results with the gallic acid method will also, because of its simplicity and accuracy, tend to displace unneutralized conductance.

TABLE 5

| Sample | P Alkalinity as $CaCO_3$, Ppm | M Alkalinity as $CaCO_3$, Ppm | Sulphate as $SO_4$ Ppm | Chloride as Cl, Ppm | Dissolved Solids, Ppm | Unneutralized Conductance, Micromhos | Ratio | Sulphuric Acid Neut. Conductance, Micromhos | Ratio | Gallic Acid Neut. Conductance, Micromhos | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 136 | 180 | 224 | 28 | 594 | 830 | 0.71 | 680 | 0.87 | 650 | 0.91 |
| 2 | 140 | 184 | 176 | 20 | 470 | 840 | 0.56 | 550 | 0.86 | 550 | 0.86 |
| 3 | 224 | 324 | 896 | 236 | 2076 | 2900 | 0.71 | 2400 | 0.86 | 2350 | 0.88 |
| 4 | 244 | 312 | 96 | 72 | 918 | 1550 | 0.59 | 1000 | 0.92 | 990 | 0.93 |
| 5 | 196 | 336 | 496 | 164 | 1480 | 2300 | 0.64 | 1780 | 0.83 | 1730 | 0.86 |
| 6 | 268 | 332 | 1008 | 356 | 2606 | 3600 | 0.72 | 3000 | 0.87 | 3000 | 0.87 |
| 7 | 472 | 604 | 592 | 81 | 1774 | 2900 | 0.61 | 1900 | 0.93 | 1900 | 0.93 |
| 8 | 604 | 740 | 768 | 104 | 2198 | 3900 | 0.56 | 2350 | 0.93 | 2300 | 0.95 |
| 9 | 820 | 972 | 880 | 128 | 2746 | 5000 | 0.55 | 3000 | 0.92 | 3000 | 0.92 |
| 10 | 1052 | 1240 | 1120 | 160 | 3568 | 6000 | 0.59 | 3750 | 0.95 | 3750 | 0.95 |

# TIPS ON HOW TO SELECT BOILER CONTROL



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# NEW UTILITY BOILERS

**A breakdown, as to size of units, pressures, temperatures, methods of firing and furnace type of 171 units representing over 70 million pounds per hour capacity ordered by electric utilities during the 15-month period from January 1, 1946 to April 1, 1947. This shows a distinct trend toward more large units in the very high-pressure, high-temperature ranges.**

IN ORDER to meet the rapidly growing load and to build up a more satisfactory reserve capacity, the electric utilities now have on order a vast amount of power generating equipment and accessories. It has recently been authoritatively stated[1] that the aggregate rating of steam turbine-generators now on order by electric utilities approximates 9 million kilowatts, some of which units will not be in operation until late in 1949, or perhaps later. No companion figures have heretofore appeared concerning the steam-generating capacity now on order or building for the utilities. Therefore, the following figures, believed to be virtually complete, reporting on steam generating units, of all makes, ordered by the electric utilities during the 15-month period from Jan. 1, 1946 to April 1, 1947, should be of considerable interest. While the placing of boiler and turbine orders do not always coincide, because of the difference in deliveries, it is significant that the aggregate boiler capacity of 70.4 million pounds of steam per hour and 9 million kilowatts turbine capacity check fairly well on the basis of a water rate of slightly under 8 lb of steam per kilowatt-hour.

The total number of steam generating units ordered by the utilities during this period was 171, representing an aggregate capacity of 70.4 million pounds of steam per hour. Of these thirteen are rated at more than 800,000 lb of steam per hour; seventy-six fall within the range of 400,000 to 800,000 lb per hr; and eighty-two under 400,000 lb per hr. In other words, more than half may be classed as large units and the average would figure about 410,000 lb.

Expressed with reference to the total capacity within each of these size groups, nearly twelve million pounds of steam per hour is represented by the first group comprising units of 800,000 lb per hr and over; more than thirty-nine million pounds per hour by the second group of 400,000 to 800,000 lb and nearly 19 million pounds per hour by the third group of units under 400,000 lb per hr.

Classifying these units with reference to pressure, ten are designed for over 1500 psi; fifty-one at between 1300 and 1500 psi; seventy-five at between 800 and 1000

[1] In a paper by Col. H. S. Bennion, Managing Director of the Edison Electric Institute, before the Midwest Power Conference, March 31–April 2, 1947.

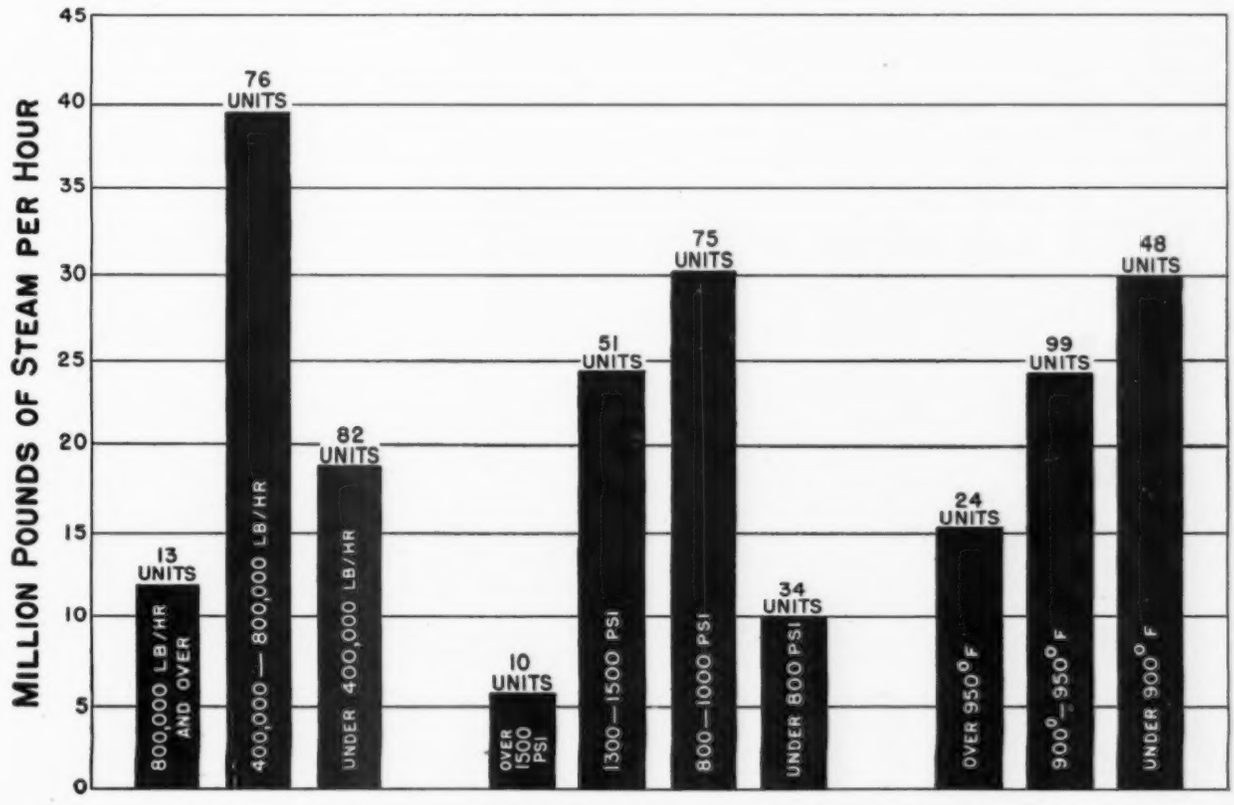


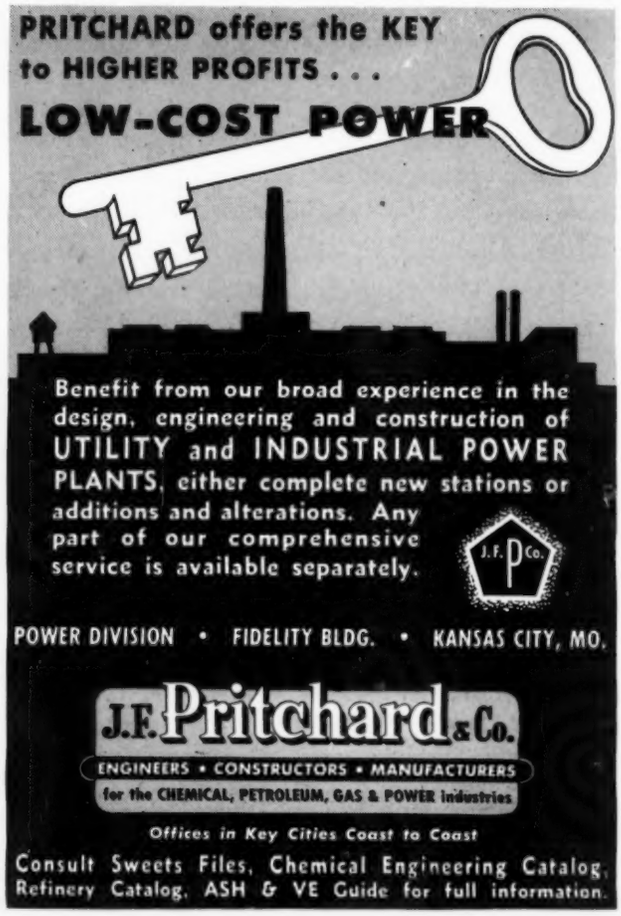

**Chart of unit sizes, pressures and steam temperatures**

psi; and thirty-four at pressures under 800 psi. Slightly more than one-third of the total capacity, or more than 24 million pounds per hour, falls within the pressure range of 1300 to 1500 psi (inclusive); and about 43 per cent in the range 800 to 1000 psi (inclusive). The maximum pressure, represented by three units, is 2300 psi.

As indicative of the present trend toward higher total steam temperatures, twenty-four of the units, representing 22 per cent of the total capacity, will operate at over 950 F, the maximum being 1050 F for six units in three different stations. However, ninety-nine units, representing 34 per cent of the capacity will operate at 900 to 950 F and forty-eight units, or 44 per cent of the capacity, will fall below 900 F. It may seem strange that, although the number of units on the lowest temperature group is less than half that in the 900 to 950 group, they account for considerably greater capacity. This is explained by the fact that a number of these are large units designed to operate at slightly under 900 F.

Pulverized coal accounts for 117 units out of the 171 total, which is nearly 70 per cent of the number and 82 per cent of the capacity. This is as might be expected. However, oil and gas firing appears to be on the increase due, probably, to plant locations, and will be employed for forty-four units. Stokers will fire only ten of the units.

Approximately 85 per cent of the pulverized-coal-fired boilers will have dry-bottom furnaces. Furnace heat releases cover a considerable range, but appear to average slightly under 20,000 Btu per cu ft. These data can perhaps best be visualized by the accompanying chart.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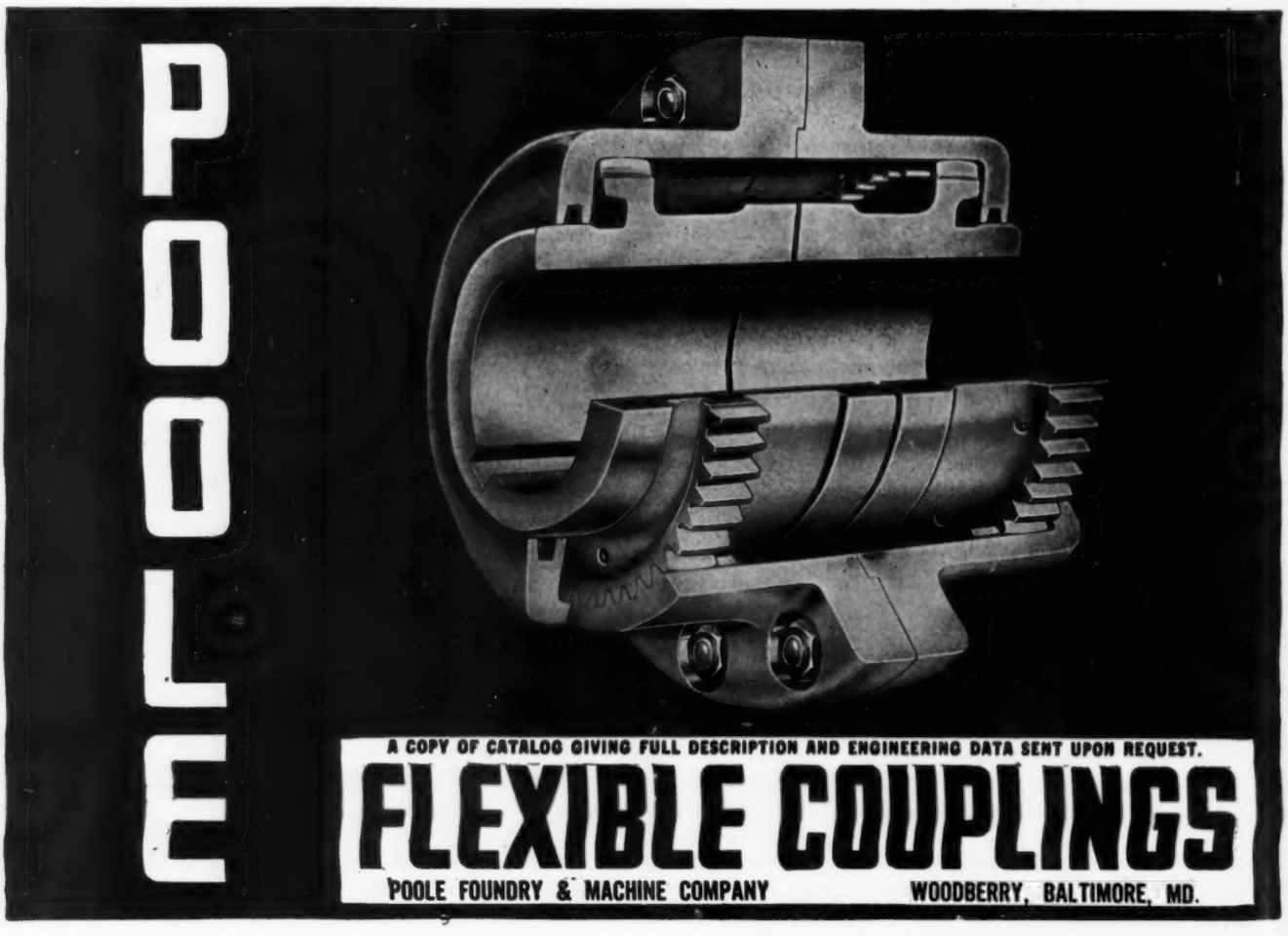
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# Engineers Are Also Citizens

By R. M. GATES

President, Air Preheater Corp.

**In this abstract of a paper before the recent Midwest Power Conference, the author analyzes the reasons for the small participation of engineers in public affairs and shows how solutions of many current public problems call for the engineering approach. He calls upon engineers, individually and collectively, to assume this responsibility.**

SCIENTISTS and engineers have progressively harnessed nature to provide mankind with tremendous power. Though terrifying in its destructive uses, this power in its constructive uses is an immeasurable contribution to the advancement of human welfare. But the creators and developers of our modern technology have not given due attention to the increased responsibilities which the possession of such power imposes on citizenship. Human relations have not been adjusted to the new technology.

### *Specialization Tends to Narrow Perspectives*

We live in an age of specialists. The scientist, generally, cannot be the master of more than a small area within one science. The versatility of a Leonardo, a Bacon, a Galileo or a Newton does not fit into the current scientific scene. Engineering, like other professions, has been divided into many specialties. Even though the dividing lines are often blurred and crossed, the tendency to specialization increases with our growing factual knowledge. All this specialization has its advantages, but also its dangers. It makes for occupational isolationism.

No occupation can successfully isolate itself from concerns common to all. We are all sharers in responsibility for government. In our form of democracy, the active participation of every economic group, including every professional group, is needed. The sphere of government in which the politician is a specialist has expanded with the growing complexity and interdependence of our economic and social life. This is true of government at every level—local, state, national. We all share in paying a constantly heavier toll for inefficient and short-sighted management of these expanding public interests. Nor is it merely a toll in taxes; it is also a toll in national strength and security.

The increasing power of government is largely an outgrowth of the increasing power of aggregations of capital and labor; of nationwide and even worldwide organizations of industry, trades, agriculture, and other occupational groups. The people, as members of their respective groups, make new demands on government for protection, for aid, for privileges, or to be let alone, while as citizens they insist that government keep the upper hand over all groups. Internal conflict at times undermines our national unity, strength, and prosperity. Thus politics has become increasingly everybody's business.

So, too, the new mechanical power which scientists and engineers have unleashed has brought the nations of the world closer together into a neighborhood. We must call it a neighborhood since the nations are no longer far separated by time or distance; also since they have become interdependent, since none may suffer or prosper without affecting others, and since they are exposed together to contagions—economic, political and what not.

### *Forgotten or Forgetting Citizens?*

In public service, of course, countless engineers are professionally and gainfully employed. They plan and build the highways and subways, the bridges and dams, the water supply and sewage disposal systems, the canals and port facilities—whatever undertakings of town, city, county, state and federal governments require engineering techniques. Every state, every city, almost every town employs engineers for planning, construction and maintenance of essential utilities. City managers are usually engineers.

It is not the engineers employed in public service as engineers, however, but engineers participating in public life as citizens, that should be the object of our concern. If we look over the list of members of Congress, of state governors, of members of state legislatures, we find few engineers. A year or two ago, Morris Cooke pointed out that among more than forty organizations selected to advise and aid our delegates to the United Nations Conference at San Francisco "scientific and engineering groups were totally absent"; yet the groups chosen comprised religious, educational, legal, agricultural, racial, business and social organizations—such social organizations, for instance, as Rotary, Kiwanis and Lions Clubs.

Some say that engineers don't like politics; others, that we are too busy in the practice of our profession. But lawyers, educators, bankers, industrialists, labor

leaders, even ministers have their occupational interests, and yet do not regard them as watertight compartments in the Ship of State. Inactivity in regard to civic responsibility means consent to policies and practices that we may disapprove or could help to improve—policies and practices that affect our professions or businesses as well as the whole life of our nation. If we engineers, as a profession, regard ourselves as unduly overlooked in political affairs of the highest national concern, perhaps it is because we ourselves have been overlooking some responsibilities. Perhaps our profession, in this regard, is not so much forgotten as forgetting.

### *Predominance of Lawyers in Public Life*

Of the 32 presidents of the United States 23 have been lawyers, although most of them practiced politics more than law. In Congress, in state and local governments, lawyers are predominant. In the Senate of the last Congress, for example, there were 70 lawyers and two engineers; in the House of Representatives, 299 lawyers and one or two engineers. In the present Congress, I am told, the total is four engineers.

Tradition, of course, is an important factor in this situation. Engineering was not generally recognized as a profession when our nation was born, certainly not in the sense that the law was recognized. Most of the educated men of the community were then likely to be lawyers, clergymen or teachers. The profession of law, by its nature, was closely tied up with government. Law courts are an arm of government. For making, interpreting, applying, enforcing, and evading laws people naturally turned to the profession in which special training and experience are found for any of those purposes.

Furthermore, lawyers are supposed to develop special skill in presenting either side of an issue persuasively. They can so analyze an issue from all sides that they can clarify or obscure it, high light the strength or weakness of either side, or make the worse appear the better reason. This skill is useful to them in gaining or retaining public office; useful also to the political parties to which they attach themselves; and often useful to the public.

### *Need of the Engineering Approach in Public Life*

The United States is now an industrial nation whose main economic, social and political problems have arisen because of the achievements of science and engineering. As the creative agents of technical progress, engineers have accumulated intimate knowledge of the materials and forces that can be used to serve human needs. They have had to maintain a realism that keeps their feet on solid ground, while at the same time exerting alert imagination to discover unattained possibilities. Knowledge, realism and some imagination make up the equipment required for engineering achievement. Can such disciplined wisdom be applied to the nontechnical problems of human relations that confront us—to the consequences of engineering achievements as witnessed in our economic, social and political life?

These problems are different from those with which engineers normally have had to wrestle. In the study and application of inanimate materials and forces, one's *self* may be kept pretty much on the outside of the circle encompassing any given problem. The perspective is one from which personal likes and dislikes, and personal prejudices, are largely excluded. But it is well-nigh impossible so to detach one's self when handling human relations or problems in which human nature is a significant factor. One's self in this area is inside the circle. Emotional reactions, conscious or unconscious preconceptions, even a philosophy of life color judgments. A scientific objective viewpoint cannot be maintained. Therefore, it is concluded by some that the engineering type of mind is not trained for operation in such a field. There may be some substance in this argument without its conclusion being accepted.

Knowledge of the materials and processes employed in the manifold activities of industry has a real value in appraisal of the expanding problems of public service. It has value in the formulation of public policies involving regulation of private enterprise and cooperation with it for the common welfare. Those who are trained and disciplined by experience to know the background and elements of a problem before they attempt to solve it, are least likely to let prejudicial and wishful thinking lead them into snap judgment and half-baked conclusions.

Realism is a habit of mind not confined to any profession or occupation, but necessarily acquired in engineering experience. Not only the background of a problem but also the practically available means and existing conditions for its solution are questions which the engineer is accustomed to ask and which he diligently seeks to answer.

And imagination, of course, is the wellspring of progress. Few, if any, other occupations make such demands on creative imagination, or help so much to develop it, as does engineering. To conceive something new, and then to plan and realize it, is forever the engineer's task. His creative imagination should be used, not only in the planning and construction of public works, but also in sharing responsibility for antecedent and consequent policies. The training which makes him adaptable and resourceful in operational situations is useful in many types of governmental problems. I would not depreciate the service of politicians by profession who use their gift of leadership for the common welfare; but large responsibilities are too often entrusted to politicians whose creative imagination may be limited to building personal or party political fences.

It becomes increasingly clear, as the influence of government is expanded over a wider range of human relations and activities, that we must outgrow this conception of politics. Wherever scientific knowledge, disciplined realism and creative imagination may be found there is certainly ample opportunity to use them in our local communities, our states, our nation and our world. Why should we not encourage the public to turn to our profession, not only for the technology that makes possible a high standard of living for our people, but also for guidance in the great task of adjusting human relations to this technological progress?

### *Where Citizenship Begins*

It may seem that I am urging engineers to give up their jobs and devote themselves to politics or at least to neglect their chosen profession for competition in another field already overcrowded with willing workers. Of course, that is not at all my purpose. It is, rather, to suggest that too few engineers, as compared with mem-

bers of other professions, are actively interested in public affairs as citizens of their respective communities and of the nation; that the engineering approach is too little utilized in the solution of problems of common concern outside of the conventional engineering field; and that engineers need to rethink their responsibilities as citizens in a society confused and floundering in efforts to adjust itself to new powers and new possibilities. Every engineer should find some time to give to civic responsibilities, and this without neglect of his professional duties. Engineering will benefit by the inspiration that grows out of these wider contacts.

Since community organization is at the base of the whole structure of government, it is here that the engineer may well first try his wings as an active citizen. Responsibilities taken at this level lead to larger responsibilities he may be well qualified to take and may find satisfaction in taking. Thus an unfortunate gap in communication between our profession and the broad field of public service—unfortunate for the national welfare—may be gradually bridged.

### *Some Problems of National Citizenship*

Among the current problems that occupy the political stage there are few, if any, which do not call for application of the engineering approach; and for the participation of engineers in efforts to solve them. Without entering into details, some of these problems are:

1. The American people are justly concerned about industrial relations; that is, how the aggregations of power in industry can avoid internal conflicts which disrupt the life of the nation. We have already had strikes of such dimensions. Are engineers concerned? Of course, they are vitally concerned. They range through industry from top executives to employees on weekly wages. Here is a job of engineering applied to human relations.

2. We seek efficiency and economy in government. What services of the Federal government have outlived their usefulness? What services need to be expanded? What new services are required? How efficiently and economically are the various services rendered? These are not questions to be answered by snap judgments of the uninformed. Is this not a field in which the engineering approach is needed?

3. We find it difficult to strike a balance between freedom of enterprise and social control. What controls that seem necessary are practicable and expedient? Are present controls exercised efficiently? Engineers are in the midst of this problem.

4. How may our national resources be used most efficiently for the common welfare—in production and distribution equal to need, with adequate incentives to capital, management and labor, with high productivity? What natural resources need to be carefully conserved, and how? Engineers, if anybody, should be able to find the answers.

### *Problems of World Citizenship*

We are also face to face with even graver international problems. They are related, of course, in one way or another, to the problems just mentioned. Here are a few:

1. Post-war relief and rehabilitation is an economic, political and social problem, as well as an engineering problem. As regards the countries devastated by war or drained of resources by war, emergency needs must be met on a practical as well as emotional basis, with a minimum of waste and a maximum of direction toward self-sufficiency.

2. Economic development is needed by various backward peoples. They vary in natural resources, in capacity for types of industry, in economic needs, in organization of society. Our aid, where it can be offered, will be effective only if intelligently adapted and long-term guidance is given.

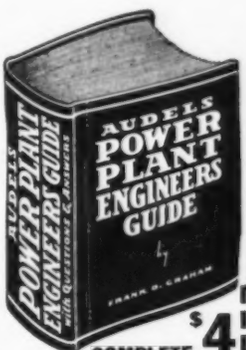
3. Allocation of world resources is pressed upon our attention. The world's unappropriated resources cannot become a free-for-all grab-bag if world peace is to be won. The allocation and use of these resources must be adjusted not by diplomats and legislators and military men alone, but with the aid of the best knowledge and foresight that can be enlightened.

4. What use shall be made of new sources of energy? Developments in nuclear energy seem to open a new chapter in man's mastery of his environment, perhaps in the history of mankind. Engineers opened this chapter; they will write on every page. And whatever social control of this source of energy is necessary or feasible, engineers must be responsible participants. Those who knew how to develop new sources of power for war should know how to apply them to the uses of peace.

These are a few of the problems that call for a broader vision, a wider participation, a readjustment of functioning on the part of engineers as engineers and engineers as citizens. Can we meet this challenge?

Leadership that guides aright the adjustments that must accompany technical progress must have a practical understanding of human nature and human relations. It should have a devotion to truth and keep a clear view of ultimate goals. Knowledge, realism, and imagination, the engineering approach, is needed here where the use of inanimate nature leaves off and the forces of human nature take over. The engineer as citizen should follow through. Active citizenship is the complement of successful engineering.

Yes, engineers can meet the challenge, individually and collectively. They have unleashed and are developing nuclear energy. Let us unleash and develop a civic energy that will entitle our profession to its proper place in the leadership of our communities, our nation and our world.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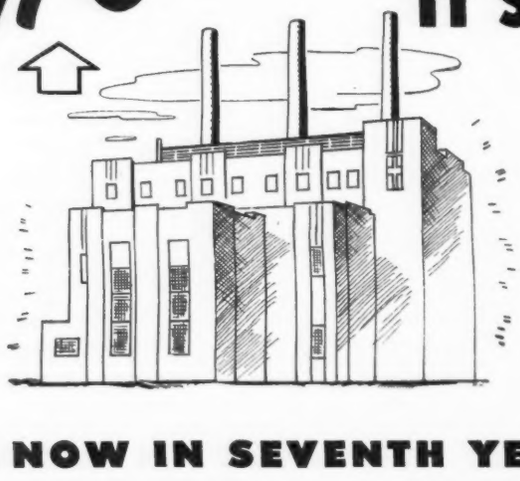

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# Application of State Workmen's Compensation to Power Plants

By LEO T. PARKER
Attorney-at-Law Cincinnati, O.

A REVIEW of late and leading higher court cases indicates that the average power plant owner in complying with State Workmen's Compensation Laws, believes that when the application is granted and the premiums are paid, complete protection is secured against suits for damages by employees who may be injured. However, in many instances this assumption leads to a false sense of security.

The original purposes of such State Compensation Laws were: (1) to assure employees reasonable compensation and money allowances for injuries sustained under *all* circumstances; and (2) to enable employers to pay monthy premiums and thereby secure protection against expensive lawsuits for heavy damages by injured employees. However, these laws only partly accomplish the intended purposes. In fact, numerous power plant owners who regularly pay premiums for industrial insurance are in many instances ultimately surprised when heavy damage allowances are awarded to injured employees.

### *Independent Contractors*

First, it may be well to review the peculiar laws relating to independent contractors, and which do *not* protect employers against damage suits.

Courts have held that an *independent contractor* is one (1) who undertakes to perform work requiring skill; (2) who is employed to produce certain results according to his own means and methods; (3) who agrees to furnish a part or all of the materials or appliances for doing the work; (4) who is paid either a gross sum of money or by piecework; (5) and who is free as to his hours of labor and under no obligation to work exclusively for his employer; (6) who is not under direct and personal control of his employer as to details of the work.

It is well known that an employer is not liable for injuries to persons and property caused by negligence of an independent contractor. Nor is an employer required to pay taxes as Social Security, State Unemployment Compensation, and Workmen's Compensation on a truly independent contractor. Although injured employees, who *apply* for compensation under a State Workmen's Compensation Act, cannot sue employers for damage, yet an independent contractor can recover damages from his employer, and all others whose negligence caused the injury. That is, both employers and their employees may be personally liable for injuries to independent contractors.

For illustration, in *Allgood v. National Company*, 27 So. (2d) 380, reported December 1946, it was shown that an employee named Allgood sued his employer and a foreman to recover $36,700 damages for injuries. During the trial testimony was given as follows: Allgood was not required to work any particular hours and no paricular time was fixed for him to complete his work. However, he agreed to perform his work expeditiously. The company furnished all materials, equipment and instruments used in the work. Also, Allgoood was covered as an employee under the employer's compensation insurance policy; was treated for his injury by the physician of the company; was carried on the payroll; social security and withholding taxes were deducted from his pay checks; and Allgood voluntarily submitted withholding exemption certificate forms for income tax purposes so that the company could make the correct income tax deduction from the amounts due. Nevertheless, the higher court held that Allgood was an independent contractor. And since the employer's foreman had negligently moved a ladder which resulted in Allgood's injury, the higher court held the foreman personally liable in $7,500 damages, and the employer liable for another $7,500 damages. This court said that independent contractors may recover damages for an injury, although the employer has regularly paid premiums under the State Workmen's Compensation Act for protection against damage suits.

### *Legal Rules*

In order that readers may realize the importance of immediately obtaining positive and dependable information regarding the usual complicated compensation laws, several late higher court cases will be cited to illustrate the chances of heavy financial losses being taken by the average plant owner.

As previously stated, the general opinion of employers is that payment of State Compensation Insurace premiums affords positive protection against suits for damages by injured employees. There are numerous reasons why this is not always so. For example, many state laws provide that every employer who employs regularly a specified number of employees (usually three) must pay State Industrial Insurance premiums. Also, such laws usually state that employers who post notices, supplied by the Commission, to the effect that they carry insurance, shall not be sued by injured employees, or their dependents, for damages. Thus, if the employer forgets to post these notices in conspicuous places, or the Industrial Commission neglects to send the notices, the employer simply is "out of luck," and the employee can sue for damages. Another part of many laws, is that employers who employ fewer than a specified number of employees may obtain insurance but that they are not protected against suits by injured employees for damages unless such employer send a *written notice* to each employee that he has paid premiums for industrial insurance. Therefore, if the employer fails to send a written notice to each employee, the employer may pay industrial insurance for years and then an injured em-

ployee, or the dependents of an employee who has been killed has the privilege of suing the employer for damages instead of accepting payments from the Industrial Commission.

Another portion of some such laws provides that employers who have paid insurance premiums may be sued by employees who are injured either wilfully or because the employer failed to comply with "lawful requirements for the protection of the lives and safety of employees."

What is meant by an employer failing to comply with "lawful requirements for the protection of the lives and safety of employees"? In order to illustrate this point let us review court decisions concerning this point.

In the case of *Willis* (91 O. S. 205) it was held that if an employer fails to install safety devices on mechanical apparatus, he may be sued by the employee instead of accepting compensation. However, this higher court also held that filing a notification by the employee of the injury constituted a demand for compensation and that the employee could not maintain a suit against the employer for damage. This higher court in reviewing the case, said:

"Having made his application for compensation from the insurance fund, plaintiff (employee) waived his right to exercise his option to institute a proceeding in court, and his proceeding in the court should have been dismissed. . . ."

For comparison, see *White*, 107 O. S. 387, where it was disclosed that a state law provides that every employee who makes application for an award, or accepts compensation from an employer waives his right to sue his employer for damages.

In another case an employee filed a request for award of compensation with the Industrial Commission which rejected the claim on the grounds that the employee was not working within the scope of the employment when the injury was sustained. The employee, then sued his employer for damages and the higher court held that he had this right.

Of course, if an employee recovers damages from his employer he cannot recover compensation also from the Industrial Commission.

For example, in a leading case (128 O. S. 372) it was disclosed that an employee was injured and later sued for damages and was paid $6500. Afterward, he sued to recover compensation from the Industrial Commission. The employee was held not entitled to the additional compensation.

In order to secure desirable protection power plant owners should be certain that all engines, machinery, equipment, and apparatus have incorporated therewith safety devices designed to protect employees from injury. Failure to do so, entitles an injured employee to sue for damages, instead of accepting State Compensation payments.

On the other hand, if an engine, machine, or equipment is properly equipped with safety devices as specified by law and these safety devices get out of order, as a result of which an employee is injured, he is bound to accept compensation payments instead of suing his employer, unless he can prove that he notified his employer that the device required repairs and the employer refused to make the necessary repairs.

To repeat, owners and operators should be certain to (1) post notices in various locations that compensation insurance is in effect; (2) carefully follow details of the laws of the state; and (3) exercise unusual care to protect independent contractors from injuries.

*Scope of Employment*

An employee is not entitled to recover compensation under the State Workmen's Compensation Act for injuries sustained outside the scope of the employment.

A review of leading higher court decisions indicates that an injury does *not* arise "in the course of employment" when it occurs while the employee is on his way to work, and before he has reached the employer's premises, providing the employer does not furnish transportation. On the other hand, an employee is within the scope of the employment if he sustains an injury while he is traveling upon the employer's premises; or while he is coming from a place maintained by the employer for the use of the employees, as an incident of the employment; or where the employee is using an automobile or other vehicle furnished by the employer or bringing property or money or some report or message connected with or pertaining to the employer's business; or when the employer controls the actions of the employee.

Therefore, it is quite apparent that an employer is liable for payment of compensation for an injury sustained by the employee, only under circumstances where the latter is actually performing an authorized act for the employer.

For illustration, in *Hantke v. Harris*, 54 Pac. 293, the testimony showed that an engineer of a plant was seriously injured while going to work in his own automobile. In holding the employer not liable, the court said:

"Freytag (the employee) was taking a course of his own choosing, had no property of his employer, was on no mission in the interest of his employer, was not in the pay of his employer, and was not subject to the orders of his employer until he arrived at the plant."

On the other hand, see *B. & B. Passmore Metal v. New Amersterdam Company*, 147 Fed. (2d) 536. This litigation involved death of an employee who fell off a motor truck while returning to the plant in the company's truck after work. The testimony showed that the employee had worked all day for the company. Instead of going directly home from the job, he decided to ride the company's truck to the plant and start from there to his home. The employees were not paid for the time consumed in riding to and from the place of work. But the higher court held the employee entitled to compensation under the State Workmen's Compensation Act.

Also, see *Casualty Reciprocal Exchange v. Johnson*, 148 Fed. (2d) 228. Here it was shown that a man named Johnson was employed as engineer. One night Johnson, while engaged in his employment at the plant, was shot and killed by some unknown person. Johnson's wife sued to recover compensation under the State Workmen's Compensation Act.

In holding the wife entitled to compensation the higher court said that an injury may arise in course of employment even though the risk or hazard be external to the employment.

Thus, this court impliedly held that an injury or death arises "out of the employment" while the employee is performing his regular duties, irrespective of the cause of the injury or death.

# A.S.M.E. Semi-Annual Meeting to Stress Fuel and Power

THE program just released for the A.S.M.E. Semi-Annual Meeting in Chicago, June 15–19, holds particular interest for power engineers, in the sessions on heat transfer, power, furnace performance factors, fuels, gas turbines, coal and ash handling, materials and nuclear energy. Also, at the several luncheons, general dinner and banquet a number of outstanding industrial leaders and specialists will be heard. High-spotting this program are the following papers and talks pertaining to the topics mentioned.

At the first Heat Transfer Session on Monday morning, June 16, "Heat Transfer by Free Convection from Heated Vertical Surfaces to Liquids" will be covered by **Prof. Y. S. Touloukian, Prof. G. A. Hawkins,** both of Purdue University, and by **Prof. Max Jacob,** of Purdue and Armour Research Foundation. A second paper at this session entitled "Heat Transfer to Boiling Water Under Pressure" will be presented by **E. A. Farber** of the University of Iowa and **Prof. R. L. Scorah** of the University of Missouri.

Also on Monday morning there will be a Power Session at which three papers will be presented. These are "Economies of Industrial Power Plants" by **B. A. Lininger,** power consultant of E. I. du Pont de Nemours & Co.; "Economies of Central Station Steam Power Plants," by **E. H. Krieg** of American Gas & Electric Service Corporation; and "Quick Starting of High-Pressure Steam Turbine Units," by **J. C. Falkner, R. S. Williams** and **R. H. Hare,** all of Consolidated Edison Company of New York.

The second Heat Transfer Session, scheduled for Monday afternoon, will have two papers. "Temperature Distribution in Some Simple Bodies Developing or Absorbing Heat at a Linear Function of Temperature," by **Prof. Max Jacob;** and "A Review of Available Data on the Dynamic Viscosity of Water and Superheated Steam," by **Profs. G. A. Hawkins, W. L. Sibbitt** and **H. L. Solberg,** all of Purdue University.

There will be a simultaneous session (Fuels I and Power II) at which **John F. Barkley, L. R. Burdick** and **A. A. Berk** of the U. S. Bureau of Mines will present a paper on "Test Data on Gas-Side Sulphate-Type Deposits on Tubes Beyond the Boiler Furnace." The second paper for presentation at this session has been prepared by **Jean Valley,** of Brussels, Belgium, and will deal with "The Possible Influence of Phosphor on the External Fouling of Boiler Tubes."

On Tuesday morning the third Power Session will have a paper reviewing "Some Heat-Pump Installations," by **E. P. Penrod** of the University of Kentucky. A simultaneous session of the Process Industries Division will have a paper by **Prof. J. H. Potter** of Johns Hopkins University on "Elimination of Waste Products of High Moisture Content in a Gas Turbine System."

Furnace Performance Factors, Fuels, Power and Heat Transfer will have simultaneous sessions on Tuesday afternoon. They will offer the following respective papers: "Variations in Heat Absorption as Shown by Measurement of the Surface Temperature of the Exposed Side of Furnace Tubes," by **L. B. Schueler** of American Gas & Electric Service Corporation; "Furnace Heat Absorption Efficiency as Shown by the Temperature Composition and Flow of the Gases Leaving the Furnace," by **W. T. Reid** of Battelle Memorial Institute, and **Paul Cohen** and **R. C. Corey** of the U. S. Bureau of Mines; "Variations in Heat Absorption as Shown by Density and Velocity Measurements of Fluid Within a Tube," by **A. R. Mumford** and **C. G. R. Humphreys,** of Combustion Engineering Company; and "Comparison and Correlation of the Results of Furnace Heat Absorption Investigations," by **A. R. Mumford,** of Combustion Engineering Company and **G. W. Bice** of American Gas & Electric Service Corporation.

Papers on "Centrifugal Casting of Stainless and Carbon Steel Tubes," by **J. W. Moore** and **J. W. MacKay** and on "The Manufacture of Tubes in Stainless Steel, Special Steel, Nickel, Monel, and Inconel by the Extrusion Method," by **H. Lorant,** will be presented at the Metals Engineering Session on Tuesday afternoon.

On Tuesday evening the fifth Power Session will be devoted to Nuclear Energy and two papers will be presented—one on "Design Problems of Atomic Power Engineering," by **B. R. Prentice** of General Electric Company; and the other on "Some Nuclear Problems," by **A. O. Nier** of Kellex Corporation.

"Oil-Burning Gas Turbines," by **Alan Howard** of General Electric Company, and "Coal-Burning Gas Turbine Plants," by **J. I. Yellott** and **C. F. Kottcamp,** Locomotive Development Committee, will be the subjects dealt with on Wednesday morning.

That afternoon there will be a Fuels Session containing two papers: the first entitled "Meter for Flowing Mixtures of Air and Pulverized Coal," by **H. M. Carlson, P. M. Frazier** and **R. B. Engdahl;** and the second, on "Fluid Devolatization of Coal for Power Plant Practice," by **A. D. Singh** and **L. J. Kane.**

Also, a simultaneous session on Materials Handling has scheduled a paper on "Coal Handling with Earth-Moving Equipment," by **R. F. Legget** and **R. L. Hearn,** both of Toronto, Can.; and a second paper entitled "Coal and Ashes Handling at Power Plants," by **G. A. Gaffert,** of Sargent & Lundy, Chicago.

The last Power Session will be held on Thursday afternoon and will have two papers, one on "An Investigation of Boiler


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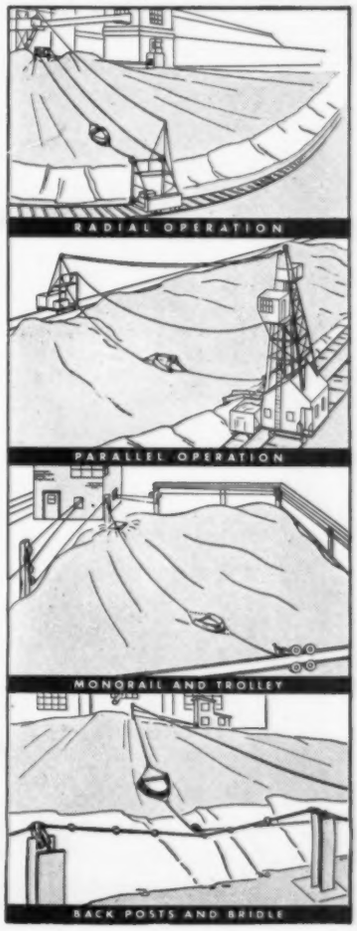


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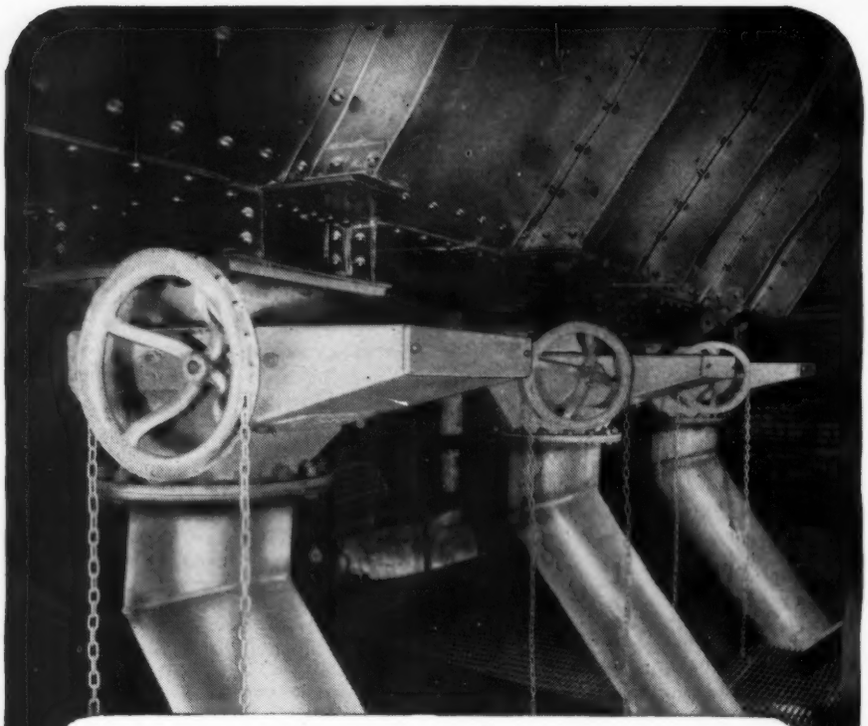

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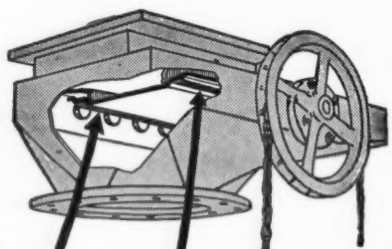

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Drum Steel After Forty Years' Service," by **H. S. Blumberg** of M. W. Kellogg Co., and **G. V. Smith** of U. S. Steel Corporation. The second paper entitled "Action of Inhibited Hydrochloric Acid on Boiler Tubes" will have as authors **J. L. Wasco** and **F. N. Alquist,** research chemists of Dow Chemical Company.

At the Monday Luncheon **President E. W. O'Brien** has selected as the subject of his talk "Broader Vistas."

The first General Dinner that evening will have as the speaker **Charles E. Wilson,** president of General Motors Corporation, and past-president **Alex D. Bailey** will preside.

The Tuesday General Luncheon will hear **L. J. Fletcher** of Caterpillar Tractor Company, discuss "Citizenship." Wednesday's Luncheon will be under the auspices of the Fuels Division with **J. E. Tobey** presiding and **H. J. Rose** of Bituminous Coal Research as the speaker whose subject will be "Trends in Solid Fuel Research." The Banquet will be held on Wednesday evening with **James D. Cunningham** as toastmaster and **R. R. Wason,** president of Manning, Maxwell & Moore as the principal speaker. At this time the ALFRED NOBLE PRIZE will be presented to **Martin Goland.**

Among the scheduled inspection trips are visits to the Calumet Generating Station of the Commonwealth Edison Company and the Armour Research Foundation.

Headquarters of the meeting and all sessions will be at the Stevens Hotel and arrangements are under the active chairmanship of **John R. Michel,** of the Commonwealth Edison Company.

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## British Central Electricity Board Reports on 1946

THE Annual Report of the Central Electricity Board covering the year 1946 stresses the supreme importance of the highest possible degree of priority for the construction of generating stations in order that unrestricted supplies of electricity may be made available at the earliest possible moment. It is pointed out that so long as the uncertainties associated with the national reconversion to a full peacetime footing persist it is not easy to form a reliable estimate of the time which will be required to re-establish the normal balance between generating capacity and the demand for electricity; but it is stated that the progress which was found possible in the first eighteen months after the end of hostilities, and the great increase in the demand for electricity, make it apparent that several years must elapse before the position can be rectified.

The factors which have brought about this situation and led to the necessity for frequent load shedding are dealt with at length, and it is pointed out that the principal contributory factor in the rapid increase in the consumption of electricity which took place during the latter part of

1946 was the stimulus given to the use of electricity for domestic and commercial heating by the shortage of coal. The Report recalls that, during the war, the Government felt it necessary in the national interest to restrict the Board's program for additional generating capacity and recognized that the present shortage would be the inevitable result of that restriction.

In 1946, the increase in demand for electricity exceeded the capacity of the new generating plant brought into service and on 54 occasions during the year, 51 of them in the latter half, it was necessary to shed load in order to avoid widespread interruptions of supply The amount of load shed reached a maximum of 930,000 kw on December 16. The Board states that load shedding on a greater scale and over longer periods will be unavoidable during the next two or three years, with a consequential dislocation of industrial production, unless means are adopted to spread the demand more evenly over the 24 hours.

*Eighteen New Stations*

Arrangements have been made for the construction of 18 new stations by the winter of 1950, by which date an aggregate of 5,892,700 kw of new plant is due for completion. The Report shows that a large measure of progress has been achieved in the standardization, both in respect of steam conditions and the sizes and designs of generating sets and boilers.

Throughout 1946, the situation in regard to coal supplies to the generating stations caused the Board even greater anxiety than in previous years. Before the war, the Board's aim was to start the winter with stocks equal to 10 to 12 weeks' winter consumption, but early in 1946, the Ministry of Fuel and Power decided that the stock level at the beginning of the following winter must be cut to 4 weeks' consumption. The Board had no doubt that such a margin would prove insufficient and warned the Ministry that widespread interference with supplies of electricity was likely to occur. By the middle of May, stocks had fallen to an average of 2 weeks' consumption in the previous winter. The rate at which stocks were replenished was much slower than in previous years and, despite some reallocation of available supplies, the maximum stock reached at the beginning of the winter was only 2,-140,000 tons, as compared with 3,200,000 tons in 1945 and 3,555,000 tons in 1944.

*Increased Coal Prices*

The Report again draws attention to the heavy financial burden imposed upon the electricity supply industry as a result of the flat rate increases per ton of coal which have taken place since the outbreak of hostilities, and states that, together with the increased costs of transport and handling charges, the average cost of fuel consumed at all the steam generating stations operated under the directions of the Board had risen from 20/3d per ton in 1938 to 38/7d in 1944, 43/4d in 1945 and 45/3d in 1946.

During the war, the steady improvement in thermal efficiency which had previously been achieved was arrested and, although there has been some improvement since the return to peace conditions, a further deterioration in the quality of fuel has prevented this improvement being reflected in a reduction in fuel consumption. The average for 1946 was 1.506 lb per kw hr sent out as compared with the 1938 figure of 1.430 lb. The combined effect of the increase in the cost of fuel and the increase in consumption per kilowatt-hour sent out resulted in the average cost per unit sent out in 1946 being 137 per cent above that in 1938.

At the end of the year, the number of selected stations associated with the Grid remained at 142. Their aggregate installed capacity was 11,588,306 kw, a net addition of 272,275 kw having been made during the year. The Grid itself comprised 5161 miles of transmission lines, of which 3675 miles are operated at 132,000 volts and 1486 miles at 66,000 or lower voltages, and 348 switching and transforming stations having an aggregate transformer capacity of 13,920,200 kva.

The total quantity of electricity generated at public supply stations in Great Britain in 1946 was 41,240,000,000 kwhr, or 10.6 per cent more than in 1945.

The maximum demand which was actually met by the Grid during the year occurred on December 18 and amounted to 9,154,000 kw as compared with 8,653,000 in the previous year. The estimated maximum potential demand was 10,130,000 kw and occurred on December 16, but on that date, owing to a larger amount of plant being out of commission, only 8,961,-000 kw could be carried.

During the working days in December the plant out of service by reason of breakdown, overhaul, unsuitable fuel, etc., averaged 15.8 per cent of the total capacity installed as compared with an average of 16.9 per cent in January 1945, when the maximum demand in that year occurred. It is explained that the higher availability of plant in 1946 was largely due to improvement in the labor position at the generating stations, which resulted in a general redcution in the time taken to overhaul equipment. The load factor on the Grid System, based on the maximum demand actually met, rose from 45.1 per cent in 1945 to 46.6 per cent in 1946.

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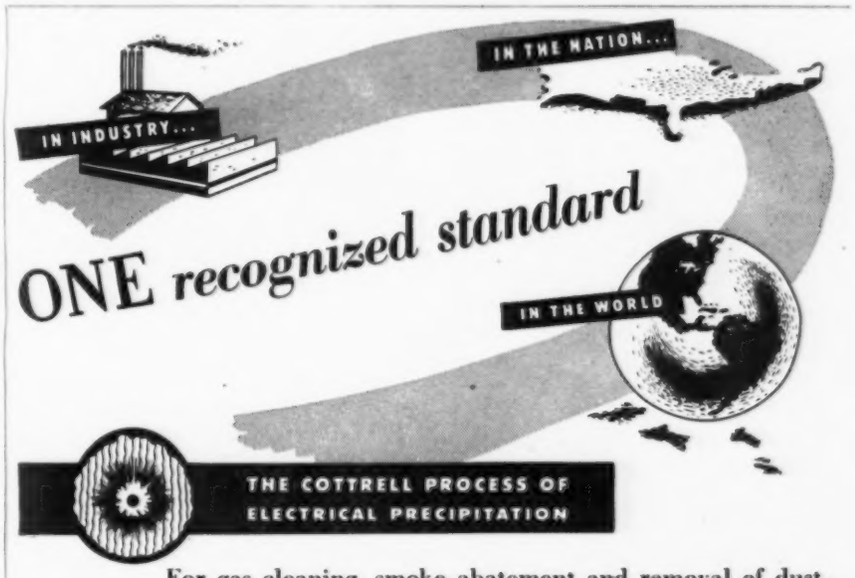
## Port Washington Performance

In the January 1947 issue "1945–1946 Performance at Port Washington," page 32, Table 2, data for Unit No. 1 for 1946 and for the 11-yr average applies to the turbine only and thus does not include the generator, condenser, etc.

For turbine-unit data for 1946, change the last three factors from 85.6, 97.3 and 97.7, to 99.5, 83.7 and 83.8; and for the 11-yr average data, change these factors from 95.7, 93.1 and 93.3, to 96.9, 91.5 and 92.0.

All other data of Table 2 apply to the complete turbine-generator unit, and to the complete boiler unit as well.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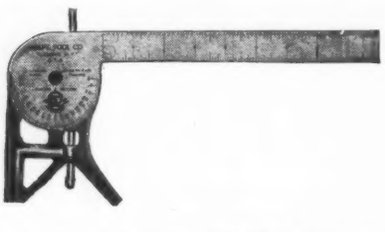
# NEW EQUIPMENT

## Center-Finder Protractor

The Interstate Sales Company announces a new tool, known as a "center-finder" protractor for use in layout work. This tool makes possible the marking of four equidistant points on the circumferance of a pipe of any size at any degree and et the same time. It serves as a 360 degree



protractor. A scale of 0-90-0 degree together with one with a double reading of $^1/_2$ in. per foot-pitch is provided. All calibrations are etched on stainless steel. A total weight of only 10 oz is made possible by the use of a specially heat-treated magnesium frame.

The list price of the "center-finder" protractor is $18.00.

## Combination Boiler Water Column and Controller

Magnetrol, Inc., Chicago, has just announced a new unit which combines both water column and multi-stage boiler-water level controller in a single unit. This combination unit offers the advantages of (1) lower first cost, (2) easier installation, (3) space saving, (4) more reliability because it eliminates cross-connection piping and (5) reduction in boiler maintenance because it requires only one blowdown instead of two.

This new unit which combines all the features of the simple magnetic operating principle found in the standard multistage Magnetrol is made in two models: Model W-126 for pressures up to 125 lb and Model W-251 for pressures up to 250 lb.

## Electrostatic Precipitator

The Koppers Co., Pittsburgh has announced its new Koppers-Elex Electrostatic Precipitator. Exclusive manufacturing and sales license rights in North America have been acquired on this Swiss-invented apparatus which will remove boiler fly ash, tar, acid mists, soda ash, fluorides, catalysts, dust and other nuisances or valuable by-products. The precipitators are designed for maximum removal of solid or liquid particles and are designed specifically to the needs of individual plants to provide any desired efficiency.

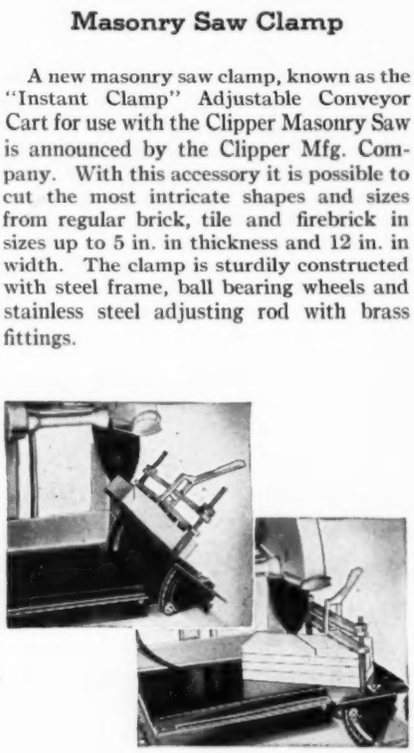
These precipitators are being engineered and manufactured at the Bartlett-Hayward Division of Koppers Company in Baltimore, Md.

## Portable Water Testing Kit

The Tru Test Laboratories, Inc., Philadelphia, offers a new portable testing kit for distillate or condensate water to provide easier, more accurate and more readily applicable on-the-job analysis of water conditions. The compact metal cabinet contains all the apparatus and standardized chemicals needed to make accurate chloride determinations and insure constant carryover control for marine and stationary high-pressure boilers. The entire kit weighs approximately 7 lb.

## Masonry Saw Clamp

A new masonry saw clamp, known as the "Instant Clamp" Adjustable Conveyor Cart for use with the Clipper Masonry Saw is announced by the Clipper Mfg. Company. With this accessory it is possible to cut the most intricate shapes and sizes from regular brick, tile and firebrick in sizes up to 5 in. in thickness and 12 in. in width. The clamp is sturdily constructed with steel frame, ball bearing wheels and stainless steel adjusting rod with brass fittings.



Two styles are available: No. 45, for Models "H" and "J" Clipper Masonry Saws, which elevate 45 degrees, and No. 90 for Models "B", "C" and "E" Clippers—a nonelevating design for angles as well as straight cutting.

## Refractory Cement

A new air setting refractory cement, called Armstrong's Air Set has been developed and is being marketed by the Armstrong Cork Company. This cold-setting cement is designed for use as a bonding mortar with firebrick and insulating firebrick but may also be used to provide a protective facing for furnace linings.

Given as an outstanding feature of Air Set is its maximum workability. Also it is said to have low shrinkability. The cement will not run out of the joints but remains in place to form a tight, dense joint capable of withstanding abrasion, slagging, and spalling as effectively as the brick itself.

Air Set is thoroughly mixed and shipped in quantities of 16, 50, 95 and 185 lb in steel drums and is ready for immediate use.

## Steam Trap

Development of a new, small-size, all-steel steam trap for service on pressures up to 250 psi has been announced by Armstrong Machine Works. This trap embodies the basic Armstrong inverted bucket and free floating valve lever design. The body and cap are steel forgings and all of the internal operating mechanism including the valve seat are stainless steel.

## Turbine Unit Heater

The Wing Turbine Revolving Unit Heater has been introduced by the L. J. Wing Mfg. Company. The fan is driven by a compact Wing all-steel steam turbine. The turbine exhaust passes into the heater section where it is used to heat the air which the fan then delivers through the Wing revolving discharge outlets. The advantages claimed are elimination of electric motor and electric power, no back pressure, no packing and no traps.

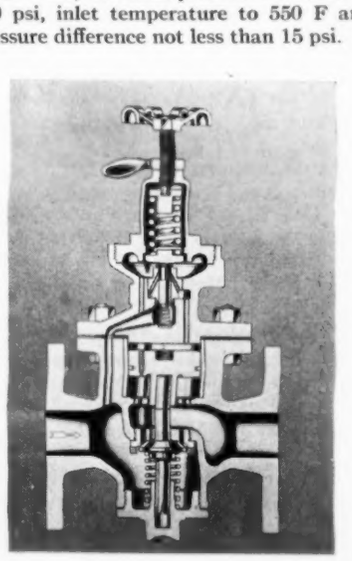
## Throttling Valve

Leslie Company announces its throttling type Unloading Valve, Class UL, for use with steam, air or gas. This valve is applicable wherever a throttling type regulating valve is required to maintain a constant inlet pressure by relieving the excess to a lower pressure system.

Quick action under sudden pressure variations as well as smooth throttling control during the entire cycle of operation are claimed for this valve.

Construction features of the valve include a high-pressure bronze body, renewable wearing parts, hard-surfaced seat ring, hardened stainless steel main and controlling valves, bronze piston, corrosion resistant piston rings and a phosphor bronze diaphragm.

The valve is available in sizes from $^1/_2$ in. to 4 in.; for inlet pressures from 25 to 300 psi, inlet temperature to 550 F and pressure difference not less than 15 psi.



## NEW CATALOGS AND BULLETINS

### Boiler Water Level Control

The Northern Equipment Company has recently released Bulletin 465 describing boiler water level control at West Reading (Pa.) Station of Metropolitan Edison Co. Included is a brief history of the plant, a description of the present equipment and the performance of the Copes Flowmatic regulators during normal and highly fluctuating loads. Reproductions of operating charts give testimony to the performance of these regulators during constant and variable load.

Another Bulletin No. 467 similarly describes the Buzzard Point Plant of Potomac Electric Power Company. Listed on the back cover of this bulletin is a Copes directory of equipment.

### Pressure Controllers

"Engineering, Operating and Maintenance Data on Pressure Controllers, External-Pilot-Operated" is the title of Bulletin No. 462 recently issued by the Leslie Co. Design features of their control pilots and associated diaphragm regulating valves are illustrated by cross-sectional views. Also included are capacity tables to guide the selection of equipment for specific applications. Instructions for installation, operation and maintenance are also presented.

### Pressure Reducing Valves

A. W. Cash Valve Mfg. Corporation has just issued Bulletin No. 199 describing Cash-Acme small volume Pressure Reducing and Regulating Valves developed for special installations. These brass valves are designed for initial pressures up to 300 psi and delivery or reduced pressures from 2 psi to 150 psi.

### Spreader Stoker Control

Bailey Meter Company has issued a new Bulletin 1022, "Control for Spreader Stokers" which gives data on approved automatic control layouts for spreader stokers. The bulletin illustrates and explains the operation of standardized component parts of the Bailey control system, which has as its primary controlling device a standard Bailey Master Steam Pressure Controller.

### Water Softeners

Cochrane Corporation announces a revised edition of publication 4021 describing carbonaceous zeolite water conditioning equipment for softening boiler feed and industrial process waters. Seven typical installations are illustrated and a number of application flow diagrams are included. Curves, tables and the various chemical reactions involved complete the technical data.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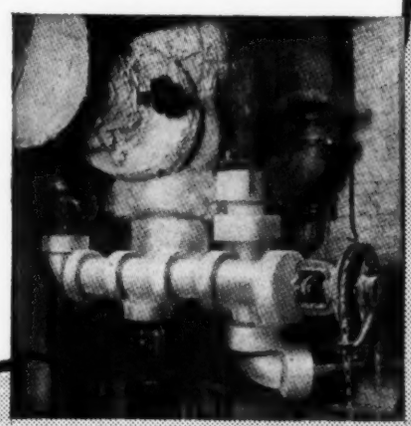

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Fig. 21 Fig. 22

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Fig. 4-F

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Fig. 12

Fig. 13 Leakless Super Try Cocks, Bronze and Forged Steel Construction

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